INSTALLATION RESTORATION PROGRAM
PHASE I: RECORDS SEARCH
15th ABW SATELLITE INSTALLATIONS, HAWAII

Prepared For

United States Air Force
AFESC/DEV
Tyndall AFB, Florida
and
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This report identified and evaluated potentially hazardous waste disposal sites at several 15th ABW satellite sites in Hawaii including Bellows AFS, Kaena Point STS, Punamano AFS, Kokee AFS and the Hickam POL storage facilities (Waikakalaua and Kipapa) and pipeline to Hickam AFB. Records of past waste handling and disposal practices at the facilities were reviewed. Interviews with past and present installation employees were conducted to develop a history of waste disposal practices. The environmental setting for effectively receiving the wastes was evaluated including soils, geology, ground water and surface water. A landfill at Bellows AFS, the Waikakalaua and Kipapa POL Storage sites, and ten POL pipeline leak areas were found to have potential to create environmental contamination and follow-on investigations (Phase II) were recommended and outlined. Other disposal areas at Bellows AFS, Kaena Point STS, Punamano AFS and Kokee AFS were found to have minimal potential to create environmental contamination.

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EXECUTIVE SUMMARY

The Department of Defense (DOD) has developed a program to identify and evaluate past hazardous material disposal sites on DOD property, to control the migration of hazardous contaminants, and to control hazards to health or welfare that may result from these past disposal operations. This program is called the Installation Restoration Program (IRP). The IRP has four phases consisting of Phase I, Installation Assessment/Records Search; Phase II, Confirmation/Quantification; Phase III, Technology Base Development; and Phase IV, Operations/ Remedial Actions. Engineering-Science (ES) was retained by the United States Air Force to conduct the Phase I, Installation Assessment/Records Search for the 15th Air Base Wing (ABW) satellite sites under Contract No. F08637 83 G0005 5001.

INSTALLATION DESCRIPTION

This study includes five 15th ABW Satellite Installations (located in Hawaii) as described below.

Bellows AFS

Bellows Air Force Station (AFS) is located on the southeastern shore of Oahu. This installation, consisting of 1571 acres, was originally established in 1917. Bellows AFS was active with aircraft during World War II. Runways were closed for fixed-wing aircraft in 1958 but helicopters still use some of the runways. The installation in recent history has served primarily as a recreation facility and a communications center.

Kaena Point STS

Kaena Point (Pt.) Satellite Tracking Station (STS) is located on the northwestern tip of Oahu. The site comprises 153 acres. Since the original construction in 1958, this facility has served as a satellite tracking station.

Punamano AFS

Punamano AFS, located on the northern tip of Oahu, was established in 1939 and served primarily as a radar station until the mid-1960's. The approximate 15-acre site has also provided training for the Hawaii Air National Guard (HANG) and currently (since the 1960's) is a radio communications facility.

Hickam POL Storage Facilities and Pipeline

The POL storage facilities remotely located from Hickam Air Force Base (AFB) are at the Waikakalaua and Kipapa sites (central Oahu). A pipeline has connected the storage tanks at these two locations with Hickam AFB since their original construction in 1943. The total land area for the storage facilities is approximately 93 acres, and the pipeline consists of about 59 acres of easement. These POL facilities initially stored AVGAS and from 1963-1971 were gradually converted to JP-4 storage.

Kokee AFS

Kokee AFS is located on the northwestern portion of Kauai. The installation consists of 11 acres and has been operated by the HANG as a radar site since 1961.

ENVIRONMENTAL SETTING

The environmental setting data reviewed for this investigation indicates several significant items relevant to the evaluation of past hazardous waste disposal and fuel handling practices at the 15th ABW Satellite Installations:

- Precipitation distribution across the islands is highly variable. The greatest amounts of rainfall are measured on the windward side and in the uplands of the islands. The amount of annual precipitation available for infiltration at a given site ranges from 6 to 59 percent.
- The surface soils at all of the installations are described as being moderately permeable.
- Shallow aquifers probably communicating with local surface waters are present at or near land surface at the following installations: Bellows AFS, POL pipeline (coastal area) and

Kokee AFS. Shallow ground water may be present locally in dike-impounded areas at Punamano AFS. All of these installations are situated in the recharge zones of their respective shallow aquifers.

- o The Hickam POL storage facilities and the northern extent of the fuel pipeline are located in the recharge area of the primary deep aquifer supplying water resources to nearly all of Oahu. Although the water level is present at great depth below land surface (700 feet at Waikakalaua and 400 feet at Kipapa), the unsaturated zone is considered to be quite permeable and, therefore, vulnerable to surface related contamination. Contamination of this aquifer due to agricultural activity near the POL facilities has been documented.
- o The surface waters entering and exiting Bellows AFS and the POL facilities are considered to be of good quality.
- o Two endangered birds inhabit the marshy lowlands of Bellows AFS. Although no threatened or endangered species is known to inhabit the other installations, they may transit any of the areas at any time.

METHODOLOGY

During the course of this project, interviews were conducted with installation personnel (past and present) familiar with past waste disposal practices; file searches were performed for past hazardous waste activities; interviews were held with local, state and federal agencies; and field surveys were conducted at suspected past hazardous waste activity sites. Fifteen sites (Figures 1 through 6, located at the end of the Executive Summary) were initially identified as potentially containing hazardous contaminants resulting from past activities and having the potential for contaminant migration. Activities at Punamano AFS and Kokee AFS were not found to involve potential contamination sites.

The sites of potential environmental contamination at the noted 15th ABW Satellite Installations have been assessed using a Hazard Assessment Rating Methodology (HARM) which takes into account factors such as site characteristics, waste characteristics, potential for contaminant migration and waste management practices. The details of the rating procedure are presented in Appendix G and the results of the assessment are given in Table 1. The rating system is designed to indicate the relative need for follow-on investigation.

FINDINGS AND CONCLUSIONS

The following conclusions have been developed based on the results of the project team's field inspection, reviews of installation records and files, interviews with installation personnel, and evaluations using the HARM system.

The areas found to have sufficient potential to create environmental contamination are as follows:

- Bellows AFS - Landfill
- Waikakalaua POL
- Kipapa POL
- POL Pipeline - Leak Nos. 1 - 10

The areas judged to have minimal potential to create environmental contamination are as follows:

- Bellows AFS - World War II Shop Area/Septic Tank System
- Kaena Pt. STS - Power Plant Site

RECOMMENDATIONS

Recommended guidelines for future land use restrictions at the various potential contamination sites are presented in Section 6. A program for proceeding with Phase II of the IRP at the 15th ABW Satellite Installations is also discussed in Section 6. The recommended actions include soil borings, monitoring wells, and a sampling and analysis program to determine if contamination exists. This would be expanded to define the extent and type of contamination if the initial step reveals site contamination. The expansion may include geophysical testing and/or additional soil borings and monitoring wells, as well as additional analytical parameters. The Phase II recommendations are summarized in Table 2.

TABLE 1

SITES EVALUATED USING THE HAZARD ASSESSMENT RATING METHODOLOGY AT 15TH ABW SATELLITE INSTALLATIONS

Rank	Site	Operation Period	HARM Score[1]
	Bellows AFS		
1	Landfill	1940's-1970's	60
2	World War II Shop Area/ Septic Tank System	1943-1946	46
	Kaena Pt. STS		
1	Power Plant Site - Tank Leak and Rinsewater	1972 (Leak); 1965 - Present (Rinsewater)	54
	Waikakalaua POL		
1	Entire Site - Sludge and Fuel Disposal	1950-1975 (Sludge) 1943-Present (Fuel)	73
	Kipapa POL		
1	Sludge Disposal and Pipe Leak Area	1950-1976 (Sludge) 1975 (Leak)	75
	POL Pipeline		
1	Leak No. 7	1978	76
2	Leak No. 10	1957-58	75
3	Leak No. 5	1954	75
4	Leak No. 9	1957-58	75
5	Leak No. 1	1951	74
6	Leak No. 3	1954	74
7	Leak No. 8	1955	74
8	Leak No. 4	1954	73
9	Leak No. 2	1954	72
10	Leak No. 6	1954	72

(1) This ranking was obtained using the Hazard Assessment Rating Methodology (HARM) described in Appendix G. Individual rating forms are in Appendix H.

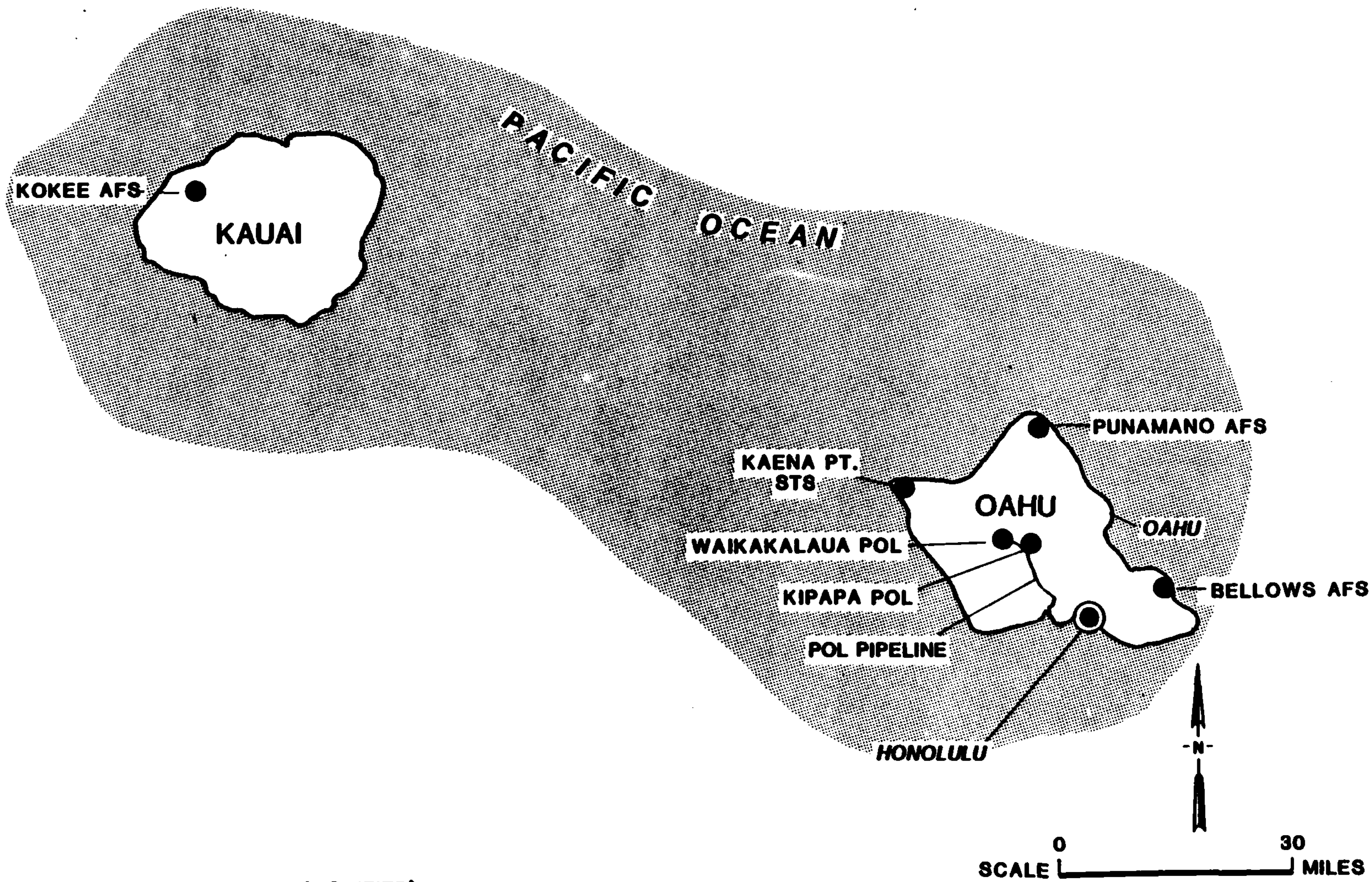
TABLE 2
RECOMMENDED MONITORING PROGRAM FOR PHASE II
IRP AT 15TH ABW SATELLITE INSTALLATIONS

Site (Rating Score)	Recommended Monitoring Program	Comments
Bellows AFS		
Landfill (60)	Install four monitoring wells, one upgradient and three downgradient from the landfill site. Construct well with Schedule 40 PVC and screen 10 to 20 feet into the upper aquifer. Sample and analyze the ground water for the parameters in Table 6.2.	Continue monitoring if sampling indicates contamination. Additional downgradient wells may be necessary to define the extent of contamination. A GC/MS scan may be run to identify any organic contaminants found.
Hickam POL Facilities		
Waikakalaua POL (73)	Obtain one to two soil borings in each of the areas with stressed vegetation and about four control borings on the site. Take 30-foot borings with samples collected at 5 foot intervals and at major soil interfaces. Fill and compact holes with clay. Analyze the soil samples for the parameters in Table 6.2. Conduct analyses on shallow samples first to determine the need for testing the deeper ones.	Take two borings in larger stressed areas and one in the smaller areas. If perched water is encountered install a well and analyze the water for the parameters in Table 6.2. If contamination is found at the bottom of the borings, deeper samples and more borings will be required to assess the extent of contamination.
Kipapa POL (75)	Obtain two soil borings in the sludge disposal area, one boring in the leak area between sludge disposal area and Kipapa Stream and one control boring. Take 30-foot borings with samples collected at 5-foot intervals and at major soil interfaces. Fill and compact holes with clay. Analyze the soil samples for the parameters in Table 6.2. Conduct analyses on shallow samples first to determine the need for testing the deeper ones.	If perched water is encountered install a well and analyze the water for the parameters in Table 6.2. If contamination is found at the bottom of the borings, deeper samples and more borings will be required to assess the extent of contamination.
POL Pipeline Leaks (72 to 76)	Obtain an average of about five soil borings at each pipeline leak site. One boring at each site should be located to serve as a control. Take borings 30-feet deep in the upland areas and 20-feet deep in the coastal areas. Sample soil at 5-foot intervals and at major soil interfaces. Fill and compact holes with clay. Analyze the soil samples for the parameters in Table 6.2. Conduct analyses on shallow samples first to determine the need for testing the deeper ones.	Some leak areas may require six to eight borings and others three or four, depending upon the specific physical location for each site. If contamination is found at the bottom of the borings, deeper samples and more borings will be required to assess the extent of contamination.

Source: Engineering-Science.

FIGURE 1

15th ABW SATELLITE SITES
AREA LOCATION

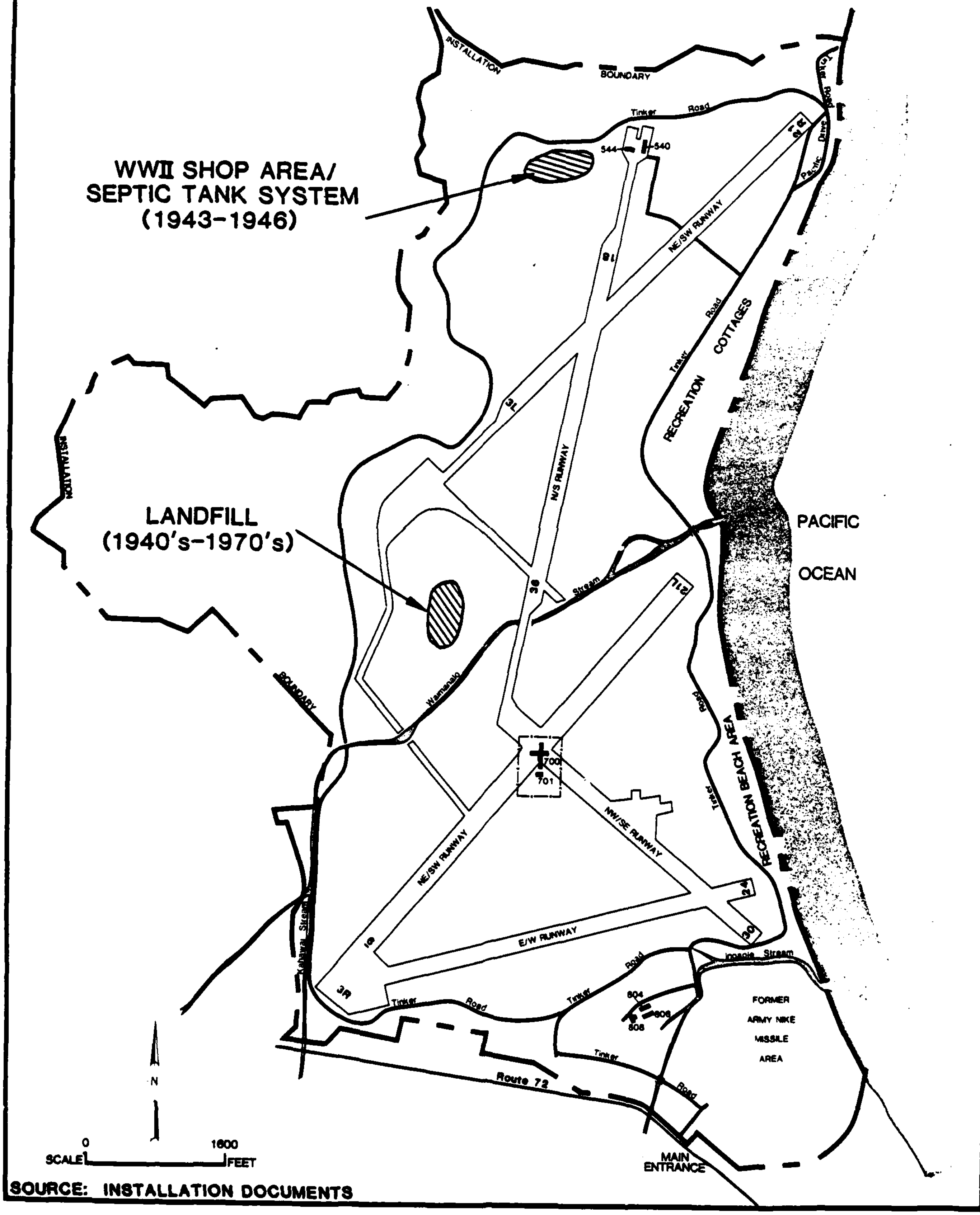


SOURCE: COMMERICAL HIGHWAY MAP (MODIFIED)

FIGURE 2

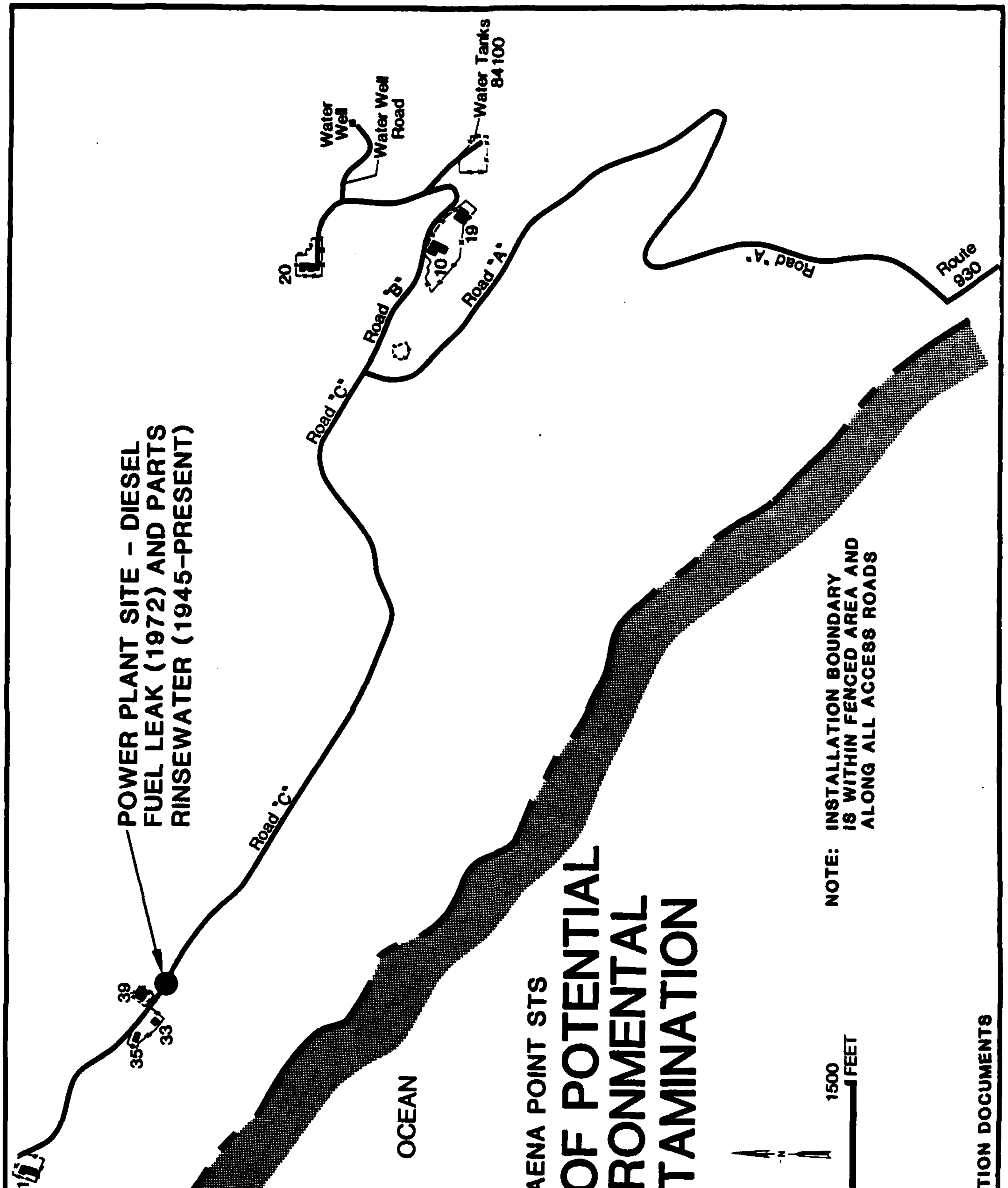
BELLOWS AFS

SITES OF POTENTIAL ENVIRONMENTAL CONTAMINATION



SOURCE: INSTALLATION DOCUMENTS

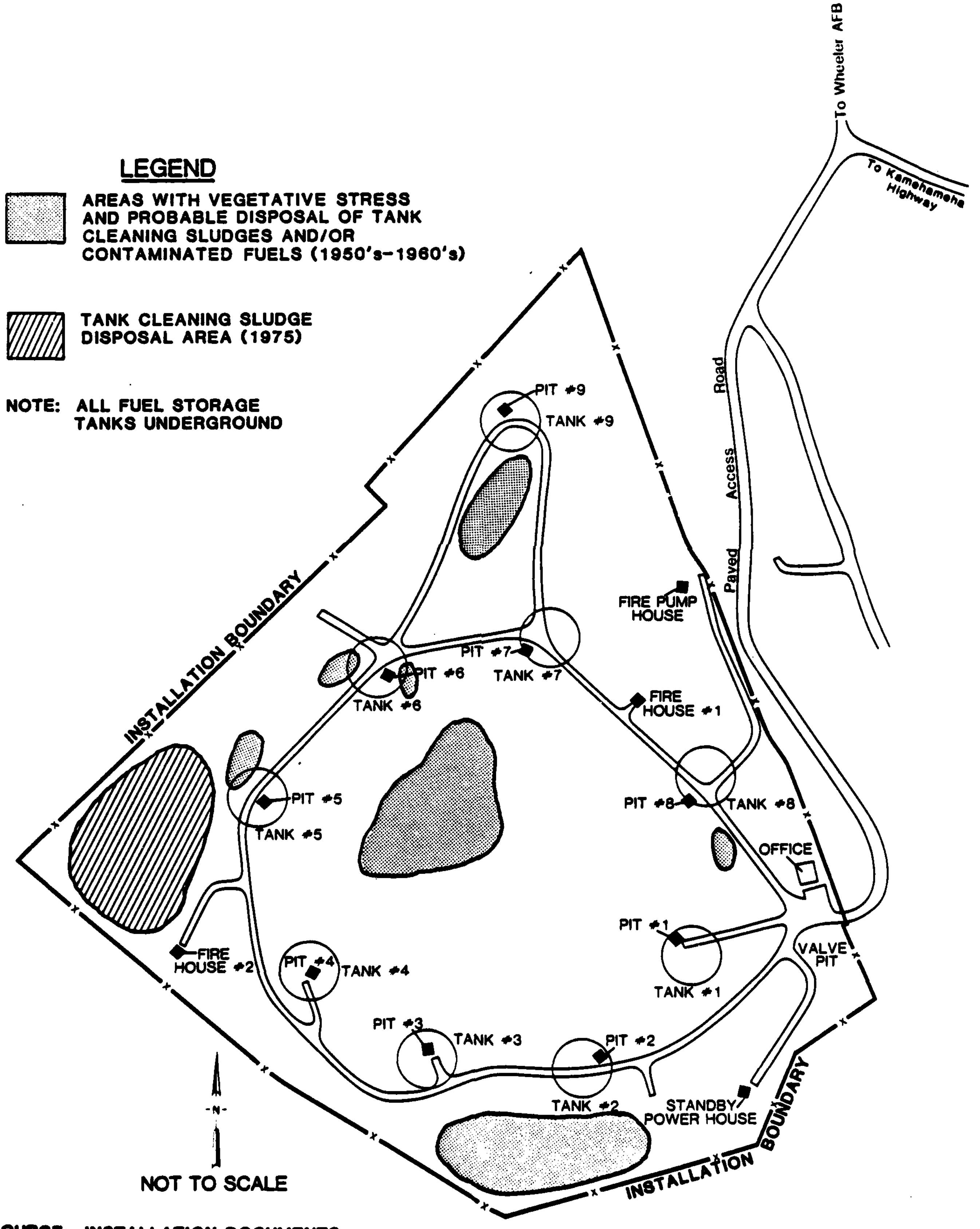
FIGURE 3



KAENA POINT STS
SITES OF POTENTIAL ENVIRONMENTAL CONTAMINATION
POWER PLANT SITE – DIESEL FUEL LEAK (1972) AND PARTS RINSEWATER (1945–PRESENT)
Road "C"
Road "C"
Road "B"
Road "A"
Road "A"
Route 930
Water Well
Water Well Road
Water Tanks 84100
20
10
19
39
33
35
41
PACIFIC
OCEAN
N
SCALE
0
1500
FEET
NOTE: INSTALLATION BOUNDARY IS WITHIN FENCED AREA AND ALONG ALL ACCESS ROADS
SOURCE: INSTALLATION DOCUMENTS

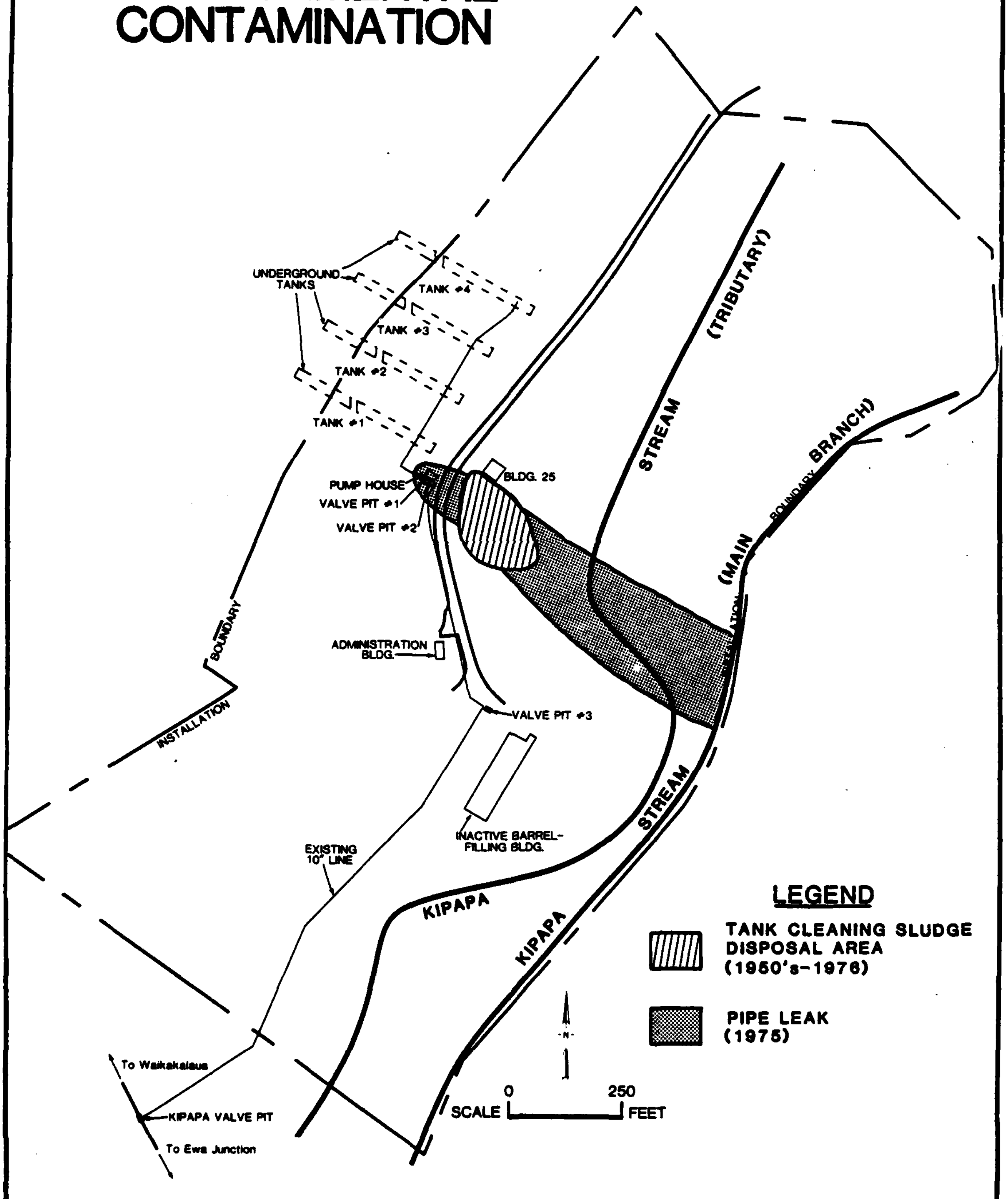
WAIKAKALAUA POL STORAGE

SITES OF POTENTIAL ENVIRONMENTAL CONTAMINATION



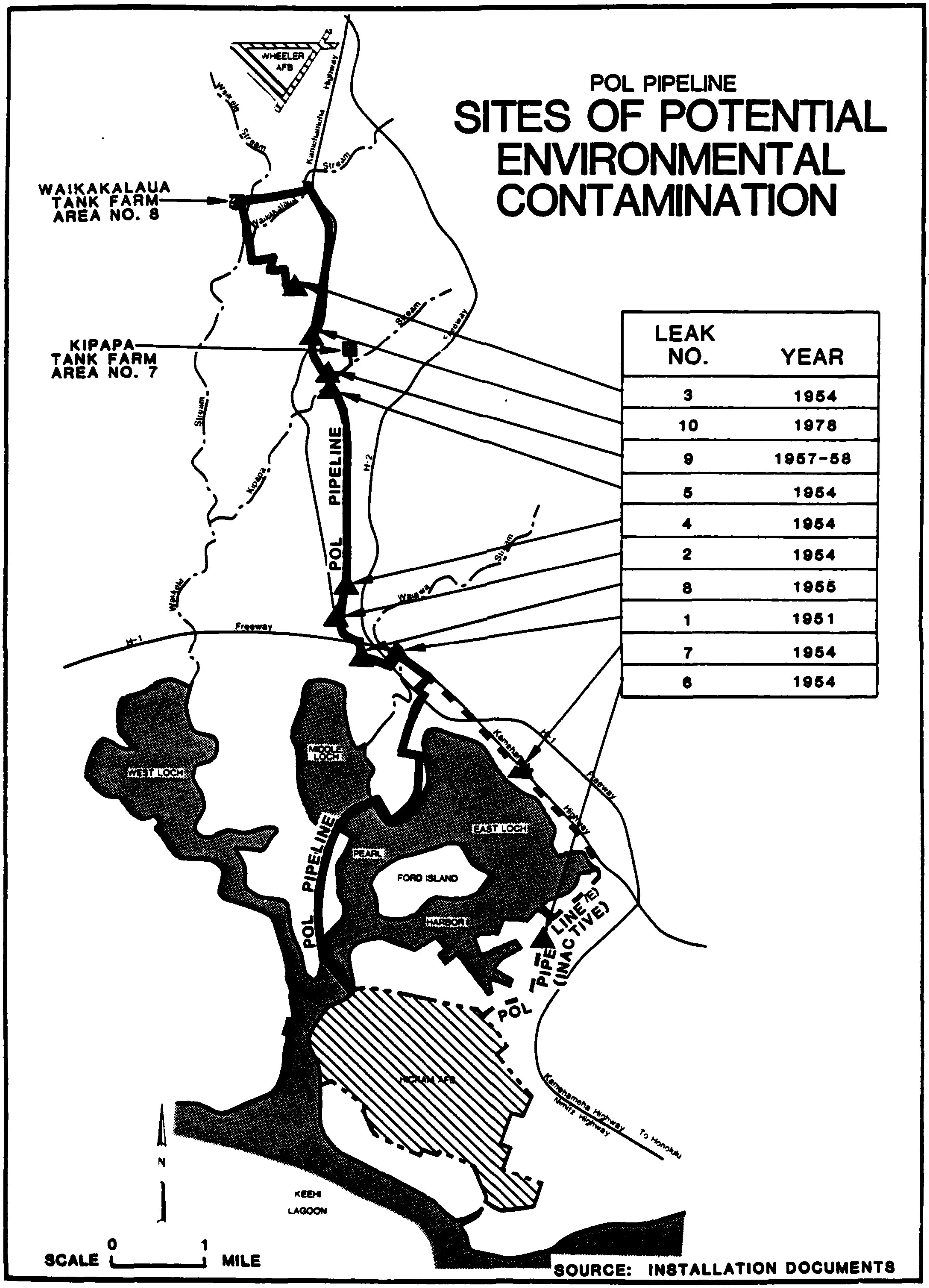
SOURCE: INSTALLATION DOCUMENTS

KIPAPA POL STORAGE
SITES OF POTENTIAL ENVIRONMENTAL CONTAMINATION



SOURCE: INSTALLATION DOCUMENTS

FIGURE 6



LEAK NO.	YEAR
3	1954
10	1978
9	1957-58
5	1954
4	1954
2	1954
8	1955
1	1951
7	1954
6	1954

SECTION 1

INTRODUCTION

BACKGROUND AND AUTHORITY

The United States Air Force, due to its primary mission of defense of the United States, has long been engaged in a wide variety of operations dealing with toxic and hazardous materials. Federal, state, and local governments have developed strict regulations to require that disposers identify the locations and contents of past disposal sites and take action to eliminate hazards in an environmentally responsible manner. The primary Federal legislation governing disposal of hazardous waste is the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. Under Section 6003 of the Act, Federal agencies are directed to assist the Environmental Protection Agency (EPA) and under Section 3012, state agencies are required to inventory past disposal sites, and Federal agencies are required to make the information available to the requesting agencies. To assure compliance with these hazardous waste regulations, the Department of Defense (DOD) developed the Installation Restoration Program (IRP). The current DOD IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5, dated 11 December 1981 and implemented by Air Force message dated 21 January 1982. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the Installation Restoration Program. DOD policy is to identify and fully evaluate suspected problems associated with past hazardous contamination, and to control hazards to health and welfare that resulted from these past operations. The IRP is the basis for response actions on Air Force installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, clarified by Executive Order 12316. CERCLA is the primary legislation governing remedial action at past hazardous waste disposal sites.

PURPOSE AND SCOPE

The Installation Restoration Program is a four-phased program (Figure 1.1) designed to assure that identification, confirmation/quantification and remedial actions are performed in a timely and cost-effective manner. Each phase is briefly described below:

- Phase I - Installation Assessment/Records Search - Phase I is to identify and prioritize those past disposal sites that may pose a hazard to public health or the environment as a result of contaminant migration to surface or ground waters, or have an adverse effect by its persistence in the environment. In this phase, it is determined whether a site requires further action to confirm an environmental hazard or whether it may be considered to present no hazard at this time. If a site requires immediate remedial action, such as removal of abandoned drums, the action can proceed directly to Phase IV. Phase I is a basic background document for the Phase II study.
- Phase II - Confirmation/Quantification - Phase II is to define and quantify, by preliminary and comprehensive environmental and/or ecological survey, the presence or absence of contamination, the extent of contamination, waste characterization (when required by the regulatory agency), and to identify sites or locations where remedial action is required in Phase IV. Research requirements identified during this phase will be included in the Phase III effort of the program.
- Phase III - Technology Base Development - Phase III is to develop a sound data base upon which to prepare a comprehensive remedial action plan. This phase includes implementation of research requirements and technology for objective assessment of adverse effects. A Phase III requirement can be identified at any time during the program.
- Phase IV - Operations/Remedial Actions - Phase IV includes the preparation and implementation of the remedial action plan.

Engineering-Science (ES) was retained by the United States Air Force to conduct the Phase I Records Search at the 15th Air Base Wing

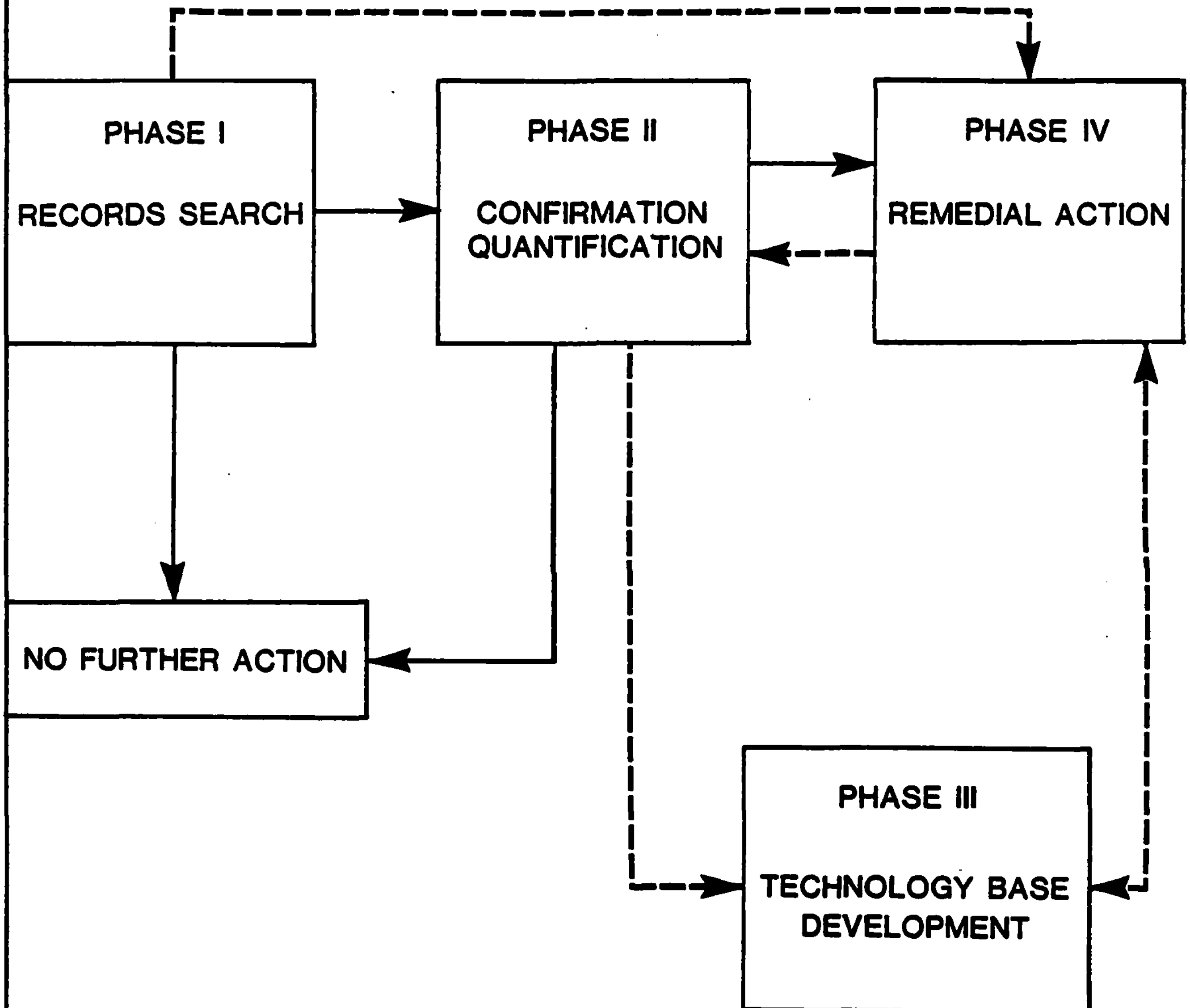


FIGURE 1.1 INSTALLATION RESTORATION PROGRAM

SOURCE: AFESC

(15th ABW) Satellite Installations under Contract No. F08637 83 G0005 5001. This report contains a summary and an evaluation of the information collected during Phase I of the IRP and recommended follow-on actions. The land areas included as part of the study are as follows:

Bellows Air Force Station (Oahu)	1571 acres
Kaena Point Station (Oahu)	153 acres
Punamano Air Force Station (Oahu)	15 acres
Hickam POL Facilities - Waikakalaua and Kipapa Storage Facilities and the POL Pipeline (Oahu)	152 acres
Kokee Air Force Station (Kauai)	11 acres

The activities performed as a part of the Phase I study scope included the following:

- Review of site records
- Interviews with personnel familiar with past generation and disposal activities
- Survey of types and quantities of wastes generated
- Determination of current and past hazardous waste treatment, storage, and disposal activities
- Description of the environmental setting at the installations
- Review of past disposal practices and methods
- Reconnaissance of field conditions
- Collection of pertinent information from federal, state and local agencies
- Assessment of the potential for contaminant migration
- Development of recommendations for follow-on actions

ES performed the on-site portion of the records search during May, 1984. The following team of professionals were involved:

- R. L. Thoem, Environmental Engineer and Project Manager, MS Sanitary Engineering, 21 years of professional experience in environmental engineering.

- J. R. Absalon, Hydrogeologist, BS Geology, 10 years of professional experience in geology and ecology.
- R. M. Palazzolo, Environmental Engineer, MS Environmental Engineering, 3 years of professional experience in environmental engineering.

More detailed information on these three individuals is presented in Appendix A.

METHODOLOGY

The methodology utilized in the 15th ABW Satellite Installations Records Search began with a review of past and present industrial operations conducted at the installations. Information was obtained from available records such as shop files and real property files, as well as interviews with 44 past and present installation employees from various operating areas. Those interviewed included current and past personnel associated with civil engineering, bioenvironmental engineering, fuels management, communications, entomology, supply, motor pool, maintenance, real property, recreation, contractors, and interservice support. A listing of interviewee positions with approximate years of service is presented in Appendix B.

Concurrent with the installation interviews, the applicable federal, state and local agencies were contacted for pertinent installation related environmental data. The agencies contacted are listed below and in Appendix B.

- o U.S. Environmental Protection Agency, Region IX (Honolulu, HI and San Francisco, CA)
- o U.S. Department of Agriculture, Soil Conservation Service (Honolulu, HI)
- o U.S. Geological Survey, Water Resources Division (Honolulu, HI)
- o Hawaii Department of Health, Permits Branch and Drinking Water Section (Honolulu, HI)
- o Honolulu Board of Water Supply, Hydrology-Geology Section and Environmental Section (Honolulu, HI)

The next step in the activity review was to identify all sources of hazardous waste generation and to determine the past management practices regarding the use, storage, treatment, and disposal of hazardous materials from the various sources on the installations. Included in this part of the activities review was the identification of all known past disposal sites and other possible sources of contamination such as spill or leak areas.

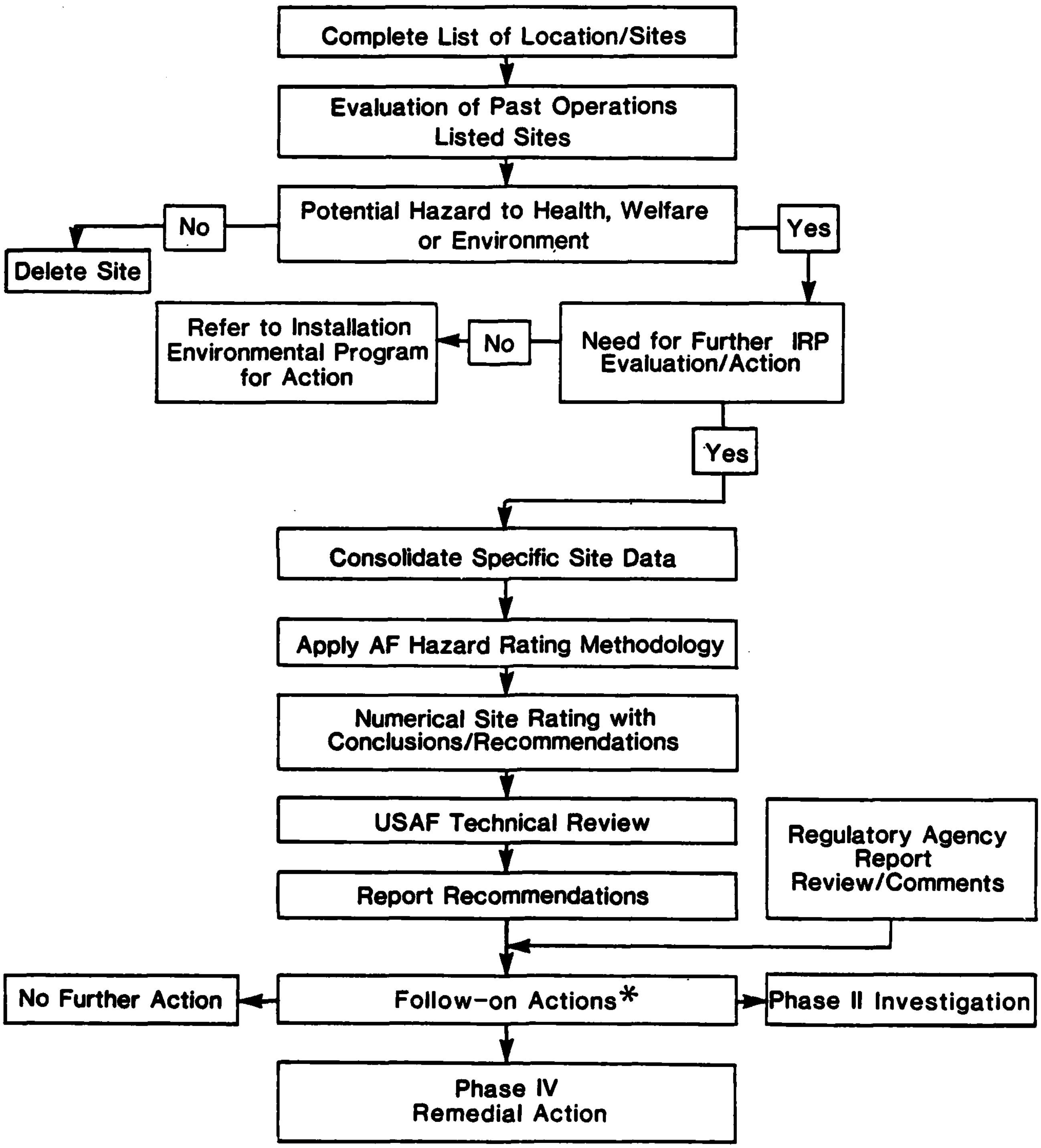
Due to the relatively small size and widely spread location of the installations, a general ground tour of the identified sites, instead of a helicoptor overflight, was made by the ES Project Team to gather site-specific information including: (1) general observations of existing site conditions; (2) visual evidence of environmental stress; (3) presence of nearby drainage ditches or surface waters; and (4) visual inspection of these water bodies for any obvious signs of contamination or leachate migration.

A decision was then made, based on all of the above information, whether a potential hazard exists to health, welfare or the environment at any of the identified sites using the Flow Chart shown in Figure 1.2. If no potential existed, the site was deleted from further consideration. For those sites where a potential hazard was identified, a determination of the need for further IRP evaluation/action was made by considering site-specific conditions. If no further IRP evaluation was determined necessary, then the site was referred to the installation environmental program for appropriate action. If a site warranted further investigation, it was evaluated and rated using the Hazard Assessment Rating Methodology (HARM). The HARM score indicates the relative potential for adverse effects on health or the environment at each site evaluated.

FIGURE 1.2

PHASE I INSTALLATION RESTORATION PROGRAM

RECORDS SEARCH FLOW CHART



*Beyond Scope of Phase I

Source: AFESC

SECTION 2

INSTALLATION DESCRIPTION

LOCATION, SIZE AND BOUNDARIES

The 15th ABW Satellite Installations included in the Phase I Study are all located in the State of Hawaii. Kokee Air Force Station (AFS) is located on the Island of Kauai, Hawaii. Bellows AFS, Kaena Point Satellite Tracking Station (STS), Punamano AFS, and the Hickam POL Facilities (Waikakalaua, Kipapa and the POL pipeline) are all located on Oahu Island, which is the combined City and County of Honolulu. Figure 2.1 shows the location of these installations in Hawaii.

Bellows AFS

Bellows AFS is located on the southeastern shore of Oahu, approximately 10 miles east of Honolulu on Route 72 (Kalanianaole Highway). The AFS has residential and commercial land abutting three sides with the Pacific Ocean along the eastern boundary. Two streams, Waimanalo and Inoaole, pass through the installation and outlet at the eastern boundary. The Bellows installation consists of 1571 acres of Air Force-owned land. Figure 2.2 shows the existing installation.

Kaena Pt. STS

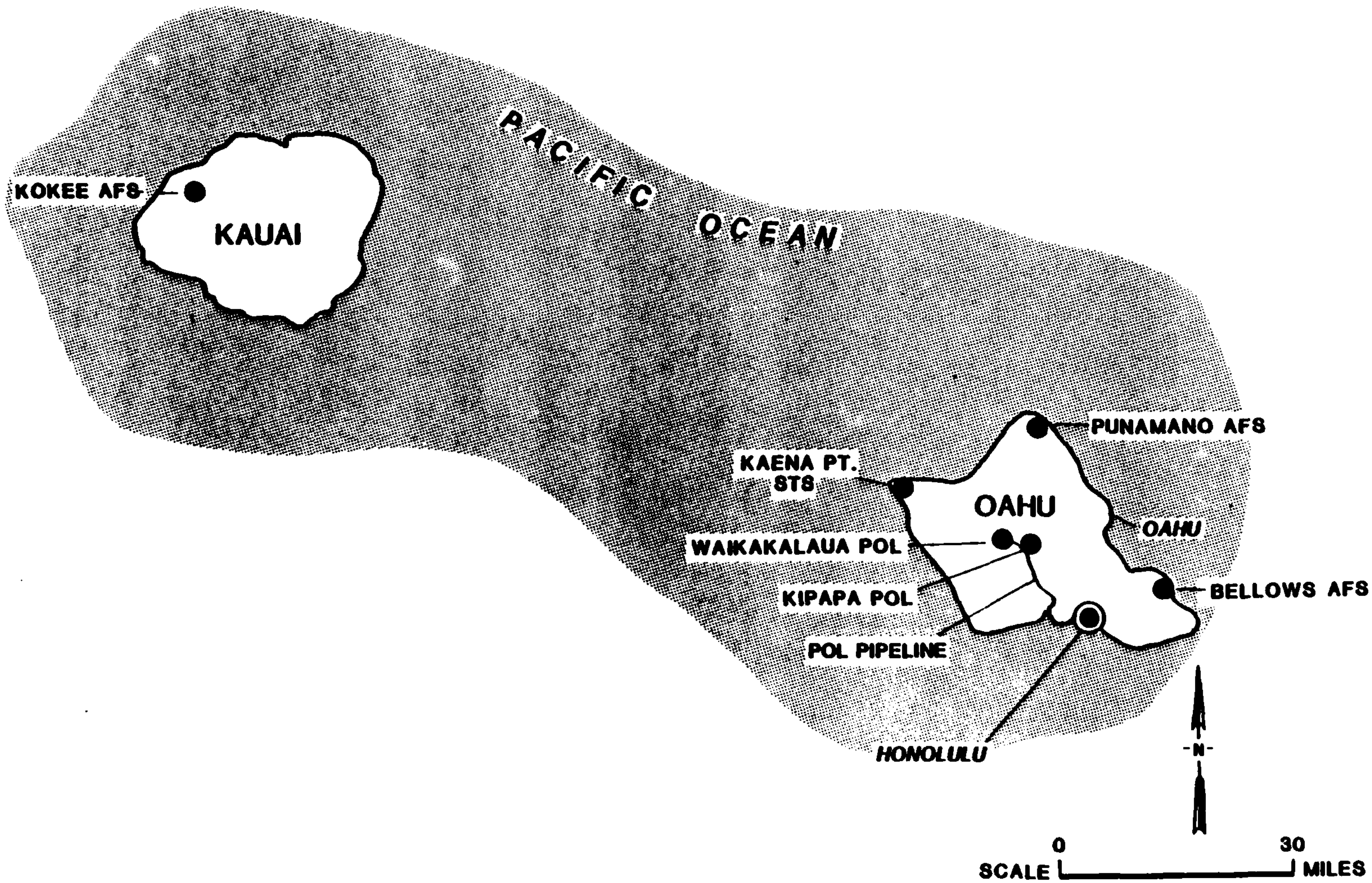
Kaena Pt. STS is located on the northwestern tip of Oahu, approximately 33 miles from Honolulu on Route 930 (Farrington Highway). It is bounded on all sides by a state park and agricultural land (Figure 2.3). The site is composed of 153 acres of land leased from the state.

Punamano AFS

Located 28 miles north-northwest of Honolulu on the northern tip of Oahu is Punamano AFS (on Route 83 - Kamehameha Highway). This installation of 15 acres is surrounded by agricultural land. The Punamano AFS consists of some Air Force-owned land but is predominantly land leased from a private owner. Figure 2.4 shows the installation except for three small areas located nearby which contain radio antennae.

FIGURE 2.1

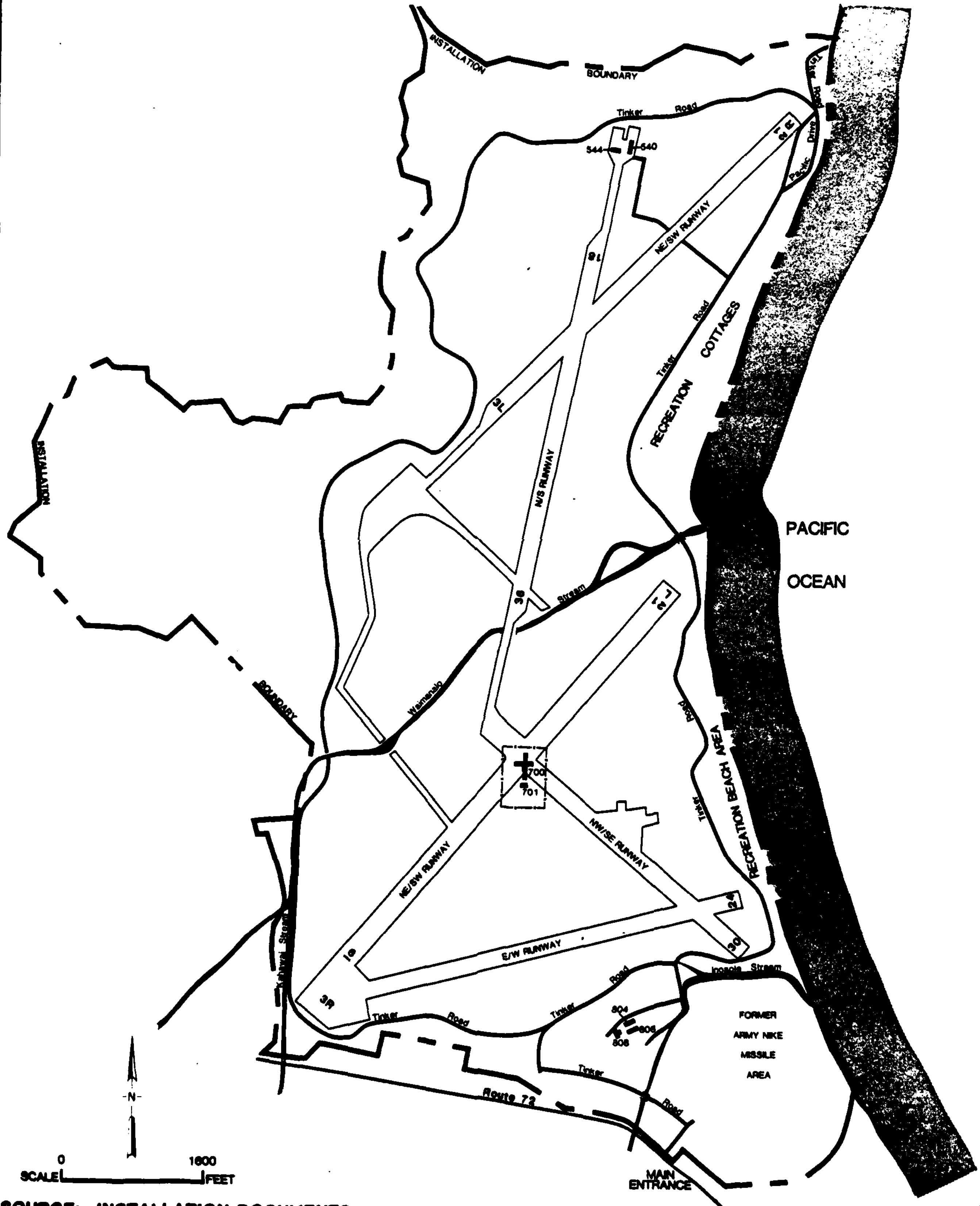
15th ABW SATELLITE SITES
AREA LOCATION



SOURCE: COMMERICAL HIGHWAY MAP (MODIFIED)

ES ENGINEERING-SCIENCE

BELLOWS AFS
INSTALLATION SITE PLAN

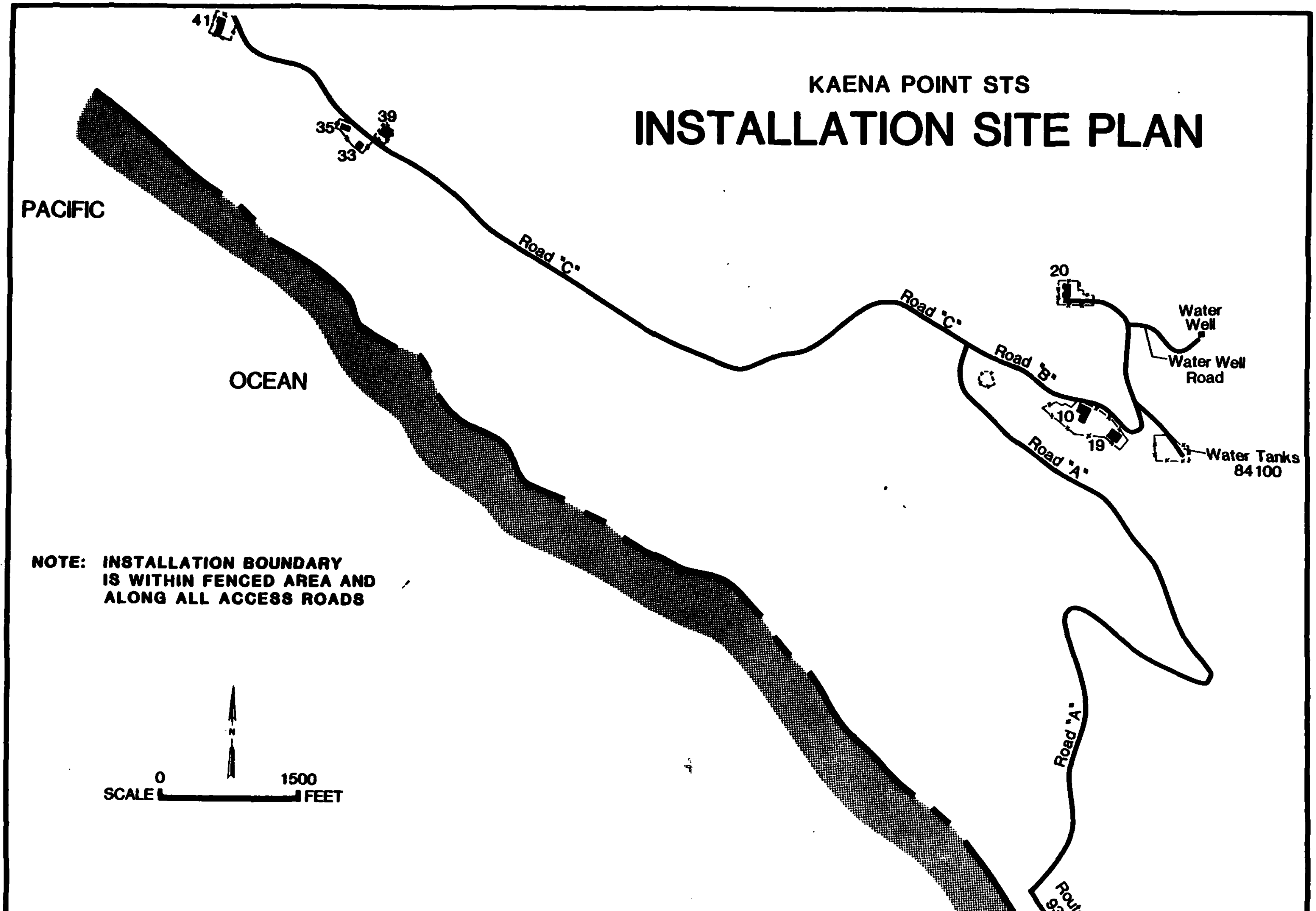


SOURCE: INSTALLATION DOCUMENTS

FIGURE 2.3

KAENA POINT STS

INSTALLATION SITE PLAN



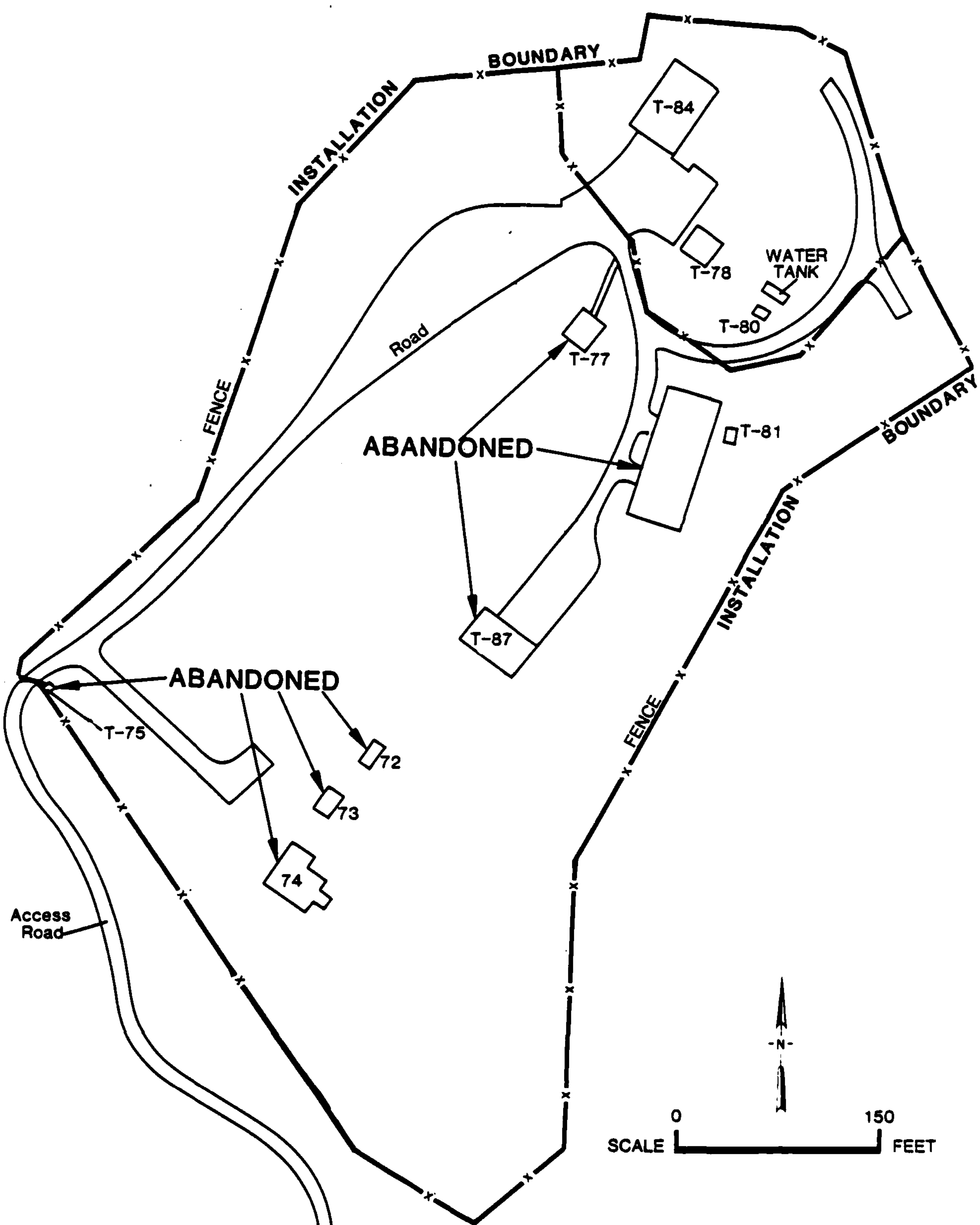
NOTE: INSTALLATION BOUNDARY IS WITHIN FENCED AREA AND ALONG ALL ACCESS ROADS

SOURCE: INSTALLATION DOCUMENTS

FIGURE 2.4

PUNAMANO AFS

INSTALLATION SITE PLAN



SOURCE: INSTALLATION DOCUMENTS

Hickam POL Facilities

The Hickam POL Facilities include fuel storage tanks at the Waikakalaua and Kipapa sites and a pipeline system (dual parallel lines) connecting these with Hickam AFB. The Waikakalaua POL facility is about 9 miles north-northwest of Hickam AFB and Kipapa is about 7 miles away in the same direction. Both are located just off Route 99, Kamehameha Highway. The total land area for these facilities is 152 acres. About 59 acres is easement, primarily for the pipeline, and the remaining 93 acres is owned by the Air Force.

Figures 2.5 and 2.6 show the site arrangements at Waikakalaua and Kipapa, respectively. Figure 2.7 shows the location of the POL storage facilities and pipeline with respect to Hickam AFB. Waikakalaua is located very close to Wheeler AFB but is predominantly surrounded by agricultural land. The Kipapa site is also primarily bordered by agricultural land.

For purposes of this IRP Study, most of the remaining parts of this report discuss the Hickam POL Facilities as three separate installations: Waikakalaua POL Storage, Kipapa POL Storage and POL Pipeline.

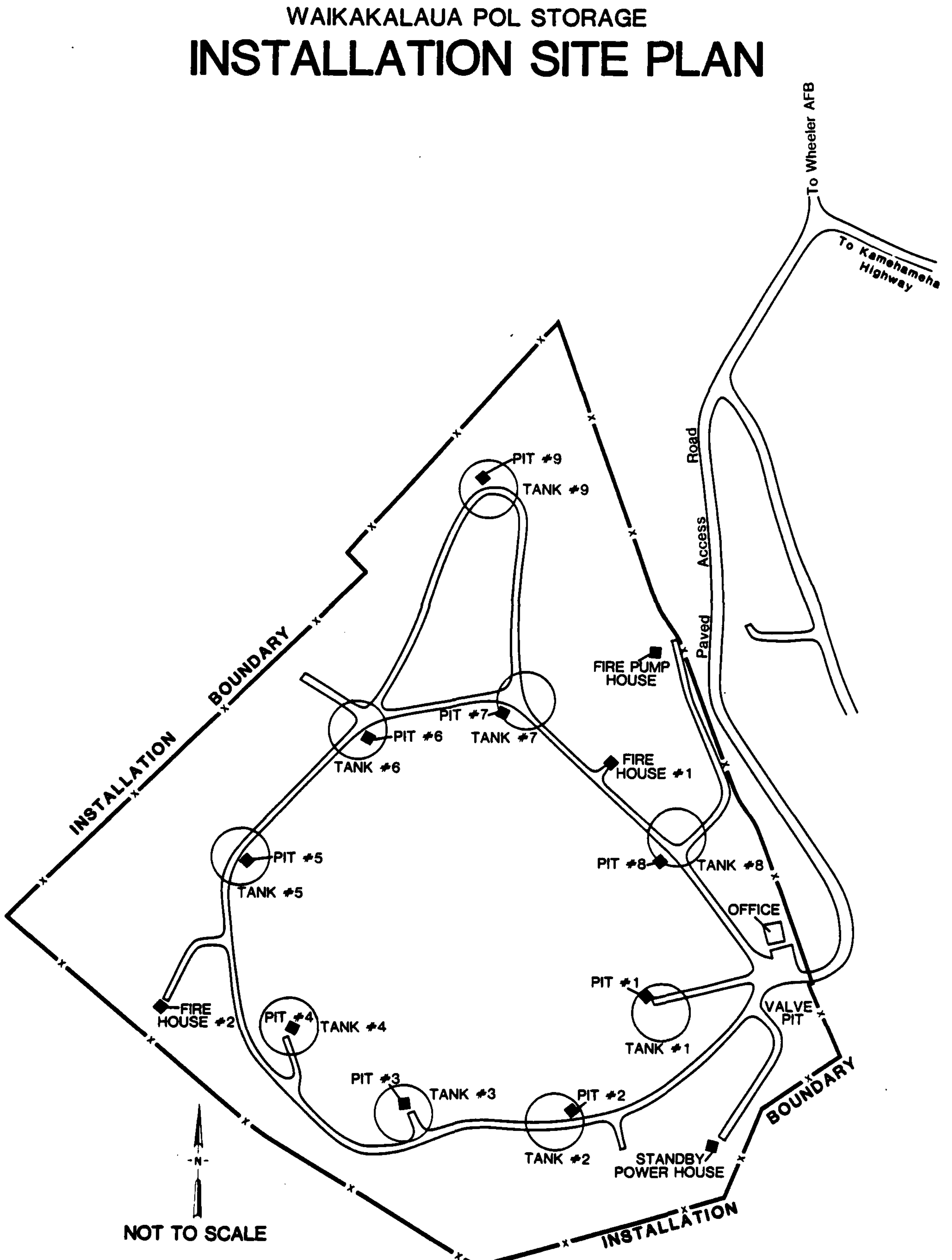
Kokee AFS

Kokee AFS is located on the northwestern portion of Kauai Island approximately 125 miles northwest of Honolulu. The installation, shown in Figure 2.8, is on an 11 acre site which is leased from the state and a private owner. The AFS is located on Route 550 (Kokee Road) in Kokee State Park and is surrounded by forest and recreational land.

HISTORY

Bellows AFS

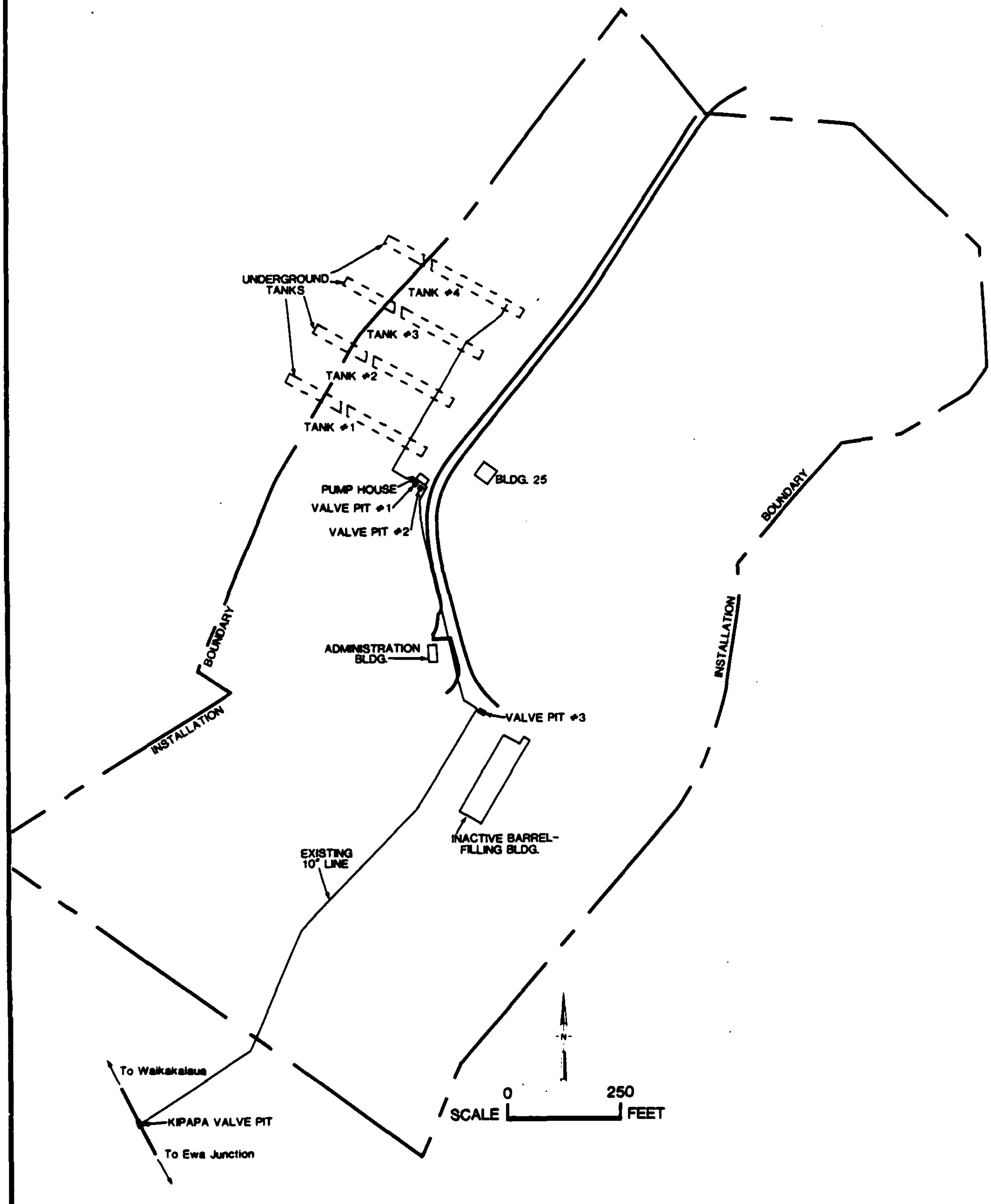
This installation was originally established in 1917 as Waimanalo Military Reservation. The activities at the installation in the 1920's are not recorded in available information. In the 1930's Bellows was used as a bombing and gunnery range by aircraft based at other nearby installations. During World War II, Bellows served primarily as an auxiliary airfield with less activity than nearby Wheeler and Hickam Air Force Bases. Aircraft activity was significantly reduced in the late 1940's and the runways were closed in 1958 for fixed-wing aircraft.



SOURCE: INSTALLATION DOCUMENTS

KIPAPA POL STORAGE

INSTALLATION SITE PLAN



SOURCE: INSTALLATION DOCUMENTS

ES ENGINEERING-SCIENCE

FIGURE 2.7

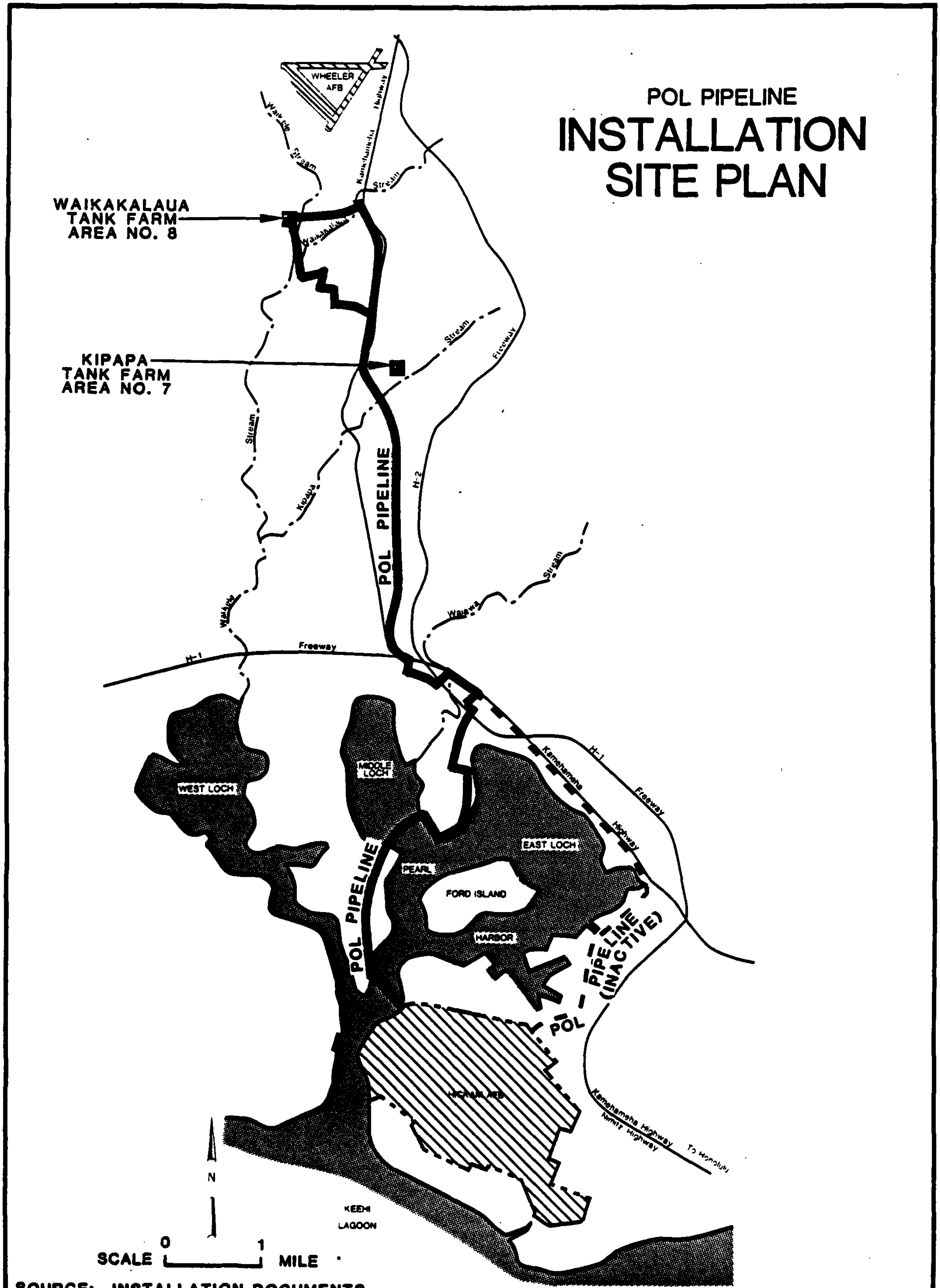
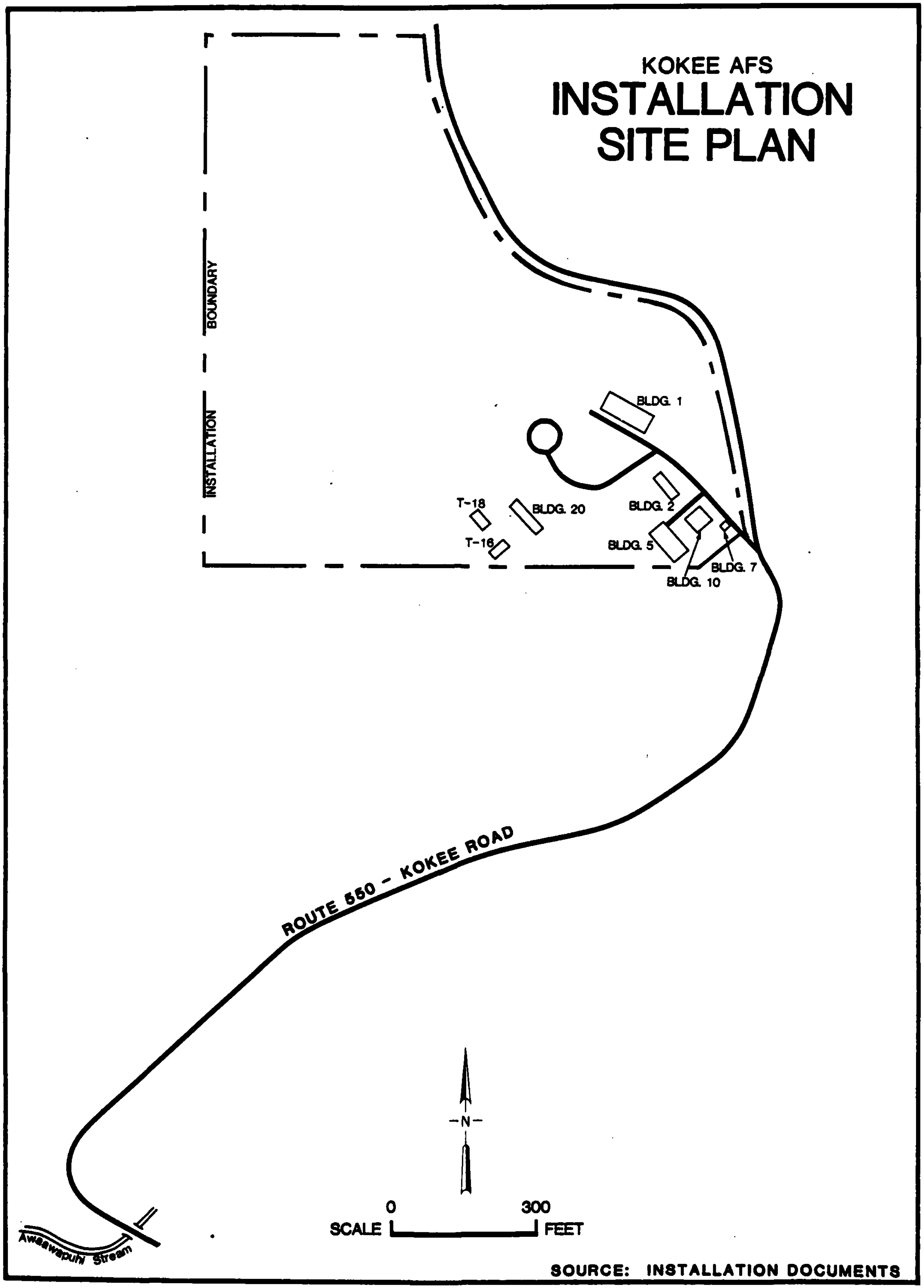

POL PIPELINE
INSTALLATION
SITE PLAN
WHEELER AFB
WAIKAKALAUA
TANK FARM
AREA NO. 8
KIPAPA
TANK FARM
AREA NO. 7
Stream
Freeway
H-2
POL PIPELINE
Waiawa
Stream
H-1
Freeway
WEST LOCH
MIDDLE LOCH
EAST LOCH
PEARL
FORD ISLAND
HARBOR
POL PIPELINE
POL - PIPELINE (INACTIVE)
Kamehameha
Highway
H-1
Freeway
HICKAM AFB
Kamehameha Highway
Nimitz Highway
To Honolulu
N
KEEHI
LAGOON
SCALE
0
1
MILE
SOURCE: INSTALLATION DOCUMENTS

FIGURE 2.8



SOURCE: INSTALLATION DOCUMENTS

In 1960 the Army built a Nike anti-aircraft missile site at Bellows which was operated until 1970.

Since 1958 Bellows has provided a training area for Marine amphibious reconnaissance, helicopter training, vehicle training and other field exercises. Bellows has had a major Air Force communications transmitter facility since 1956. Bellows also has, since the mid 1940's, served as a major recreation facility for military and DOD civilian personnel.

Kaena Pt. STS

The Kaena Pt. STS has served as a satellite tracking station since it was originally established in 1958.

Punamano AFS

This installation was established in 1939 as The Kahuku Military Reservation. During World War II it was used as a mobile radar site and as an Army fire control station. After the war Punamano was used only as a radar station. From 1955 to 1964 it was used for periodic training purposes by the Hawaii Air National Guard (HANG). Since the mid 1960's Punamano has served as a radio communications facility.

Hickam POL Facilities

The Hickam POL facilities were completed in 1943 and immediately became an active storage and dispensing system in support of the World War II efforts. The facilities have, since the original construction, been used to provide fuel for Hickam AFB, the Barbers Point Naval Air Station and the pier facilities at Pearl Harbor. The Kipapa POL storage facility had a barrel/drum filling operation which functioned from the early 1940's until about 1950-52.

Kokee AFS

The site which is currently occupied by the Kokee AFS was used during World War II as a radar station and then returned to the Territory of Hawaii in 1949. In 1961 the Kokee AFS began operations. It has served since 1961 as a radar station.

ORGANIZATION AND MISSION

The primary organizations and mission of each of the 15th ABW Satellite Installations are discussed in the following sections.

Appendix C describes the major assigned/supported units and tenants at each installation.

Bellows AFS

Detachment 1, 15th ABW is the host unit at Bellows. The major assigned/supported units include the 1957th Communications Group, 1st Marine Brigade Detachment and the 291st Maintenance Co. of the Hawaii Army National Guard (HARNG). There are three primary missions for Bellows AFS: 1) provide defense communications facilities, 2) provide a training area for the Marine Corps and 3) provide a recreational area for DOD personnel.

Kaena Pt. STS

The host unit at Kaena Pt. is the 15th ABW but all operations at the installation are under the direction of Detachment 6, Air Force Satellite Control Facility (AFSCF). The primary mission of the facility is to track, command and process data for DOD space vehicles. A tenant assisting in this mission is WSMC/Federal Electronics Corporation (ITT). The Army provides maintenance and other facility support at Kaena Pt. and is a tenant at the installation.

Punamano AFS

The 15th ABW is the host unit at Punamano AFS but all operations are under the direction of the 1891st Communications Squadron from Wheeler AFB. The mission of the installation is to provide a communications link with the PACAF Command Control Radio Network. The Army from Schofield Barracks provides maintenance and other facility support functions.

Hickam POL Facilities

The 15th ABW, Liquid Fuels, is the host unit for the Hickam POL Storage facilities and pipeline. The mission of these facilties is to provide a dependable fuel supply for support of the Hickam AFB and other military operations in the Pearl Harbor area.

Kokee AFS

The 15th ABW is the host unit at Kokee AFS but all operations are directed by the Hawaii Air National Guard's 150th Aircraft Control and Warning Squadron. The squadron's primary mission at the Kokee installation is radar detection and identification.

SECTION 3

ENVIRONMENTAL SETTING

The environmental setting of the 15th ABW Satellite Installations is described in this section with the primary emphasis directed toward the identification of features that may facilitate the migration of hazardous waste contaminants from the installations. Environmentally sensitive conditions pertinent to the study are highlighted at the end of this section. This section includes site-specific discussions of the natural properties of the installations.

METEOROLOGY

Rainfall is highly variable across the Hawaiian Archipelago, ranging from less than ten inches annually at Puako on leeward Hawaii to some 450 inches annually in the Kauai uplands (from Takasaki, 1978 and University of Hawaii, 1983). The dramatic variation in rainfall distribution is caused by orographic effects related to topography and exposure. By contrast, Takasaki (1978) reports the open-ocean rainfall near the islands averages 25 inches per year; overland rainfall averages 70 inches. Ideally, the westerly trade winds bring the largest quantities of precipitation to the east-facing uplands and mountainous regions, while the lowlands generally receive the least. Table 3.1 summarizes generalized climatic data for the study areas and presents approximations of evapotranspiration, runoff and water available for recharge, based on figures generated for the hydrographic areas in which the individual sites are located. The information is presented in this manner in order to provide climatic data for sites where no sitespecific information has been collected. Figure 3.1 depicts rainfall distribution for the islands of Kauai and Oahu. Study area annual precipitation varies from 30 inches at Kaena Point, Oahu, to some 45 inches at Punamano AFS, Oahu. The intensity of a 24-hour, one-year storm on Oahu

TABLE 3.1

STUDY AREA CLIMATOLOGIC DATA SUMMARY

Site	Hydrographic Area	Rainfall (in.)	Evapotrans-piration (in.)	(%)	Runoff (in.)	(%)	Ground-Water Recharge (in.)	(%)
1. Punamano AFS, Oahu	I	45	15	33	14	31	16	36
2. Bellows AFS, Oahu	II	35	16	45	14	39	5	16
3. Hickam POL Storage Facilities, Oahu	IV	35	9	25	5	16	21	59
4. Hickam POL Pipeline, Oahu	IV	30	7	25	5	16	18	59
5. Kaena Point Station Oahu	V & VI	30	18	60	6	20	6	20
6. Kokee AFS, Kauai	IV	62	13	21	45	73	4	6

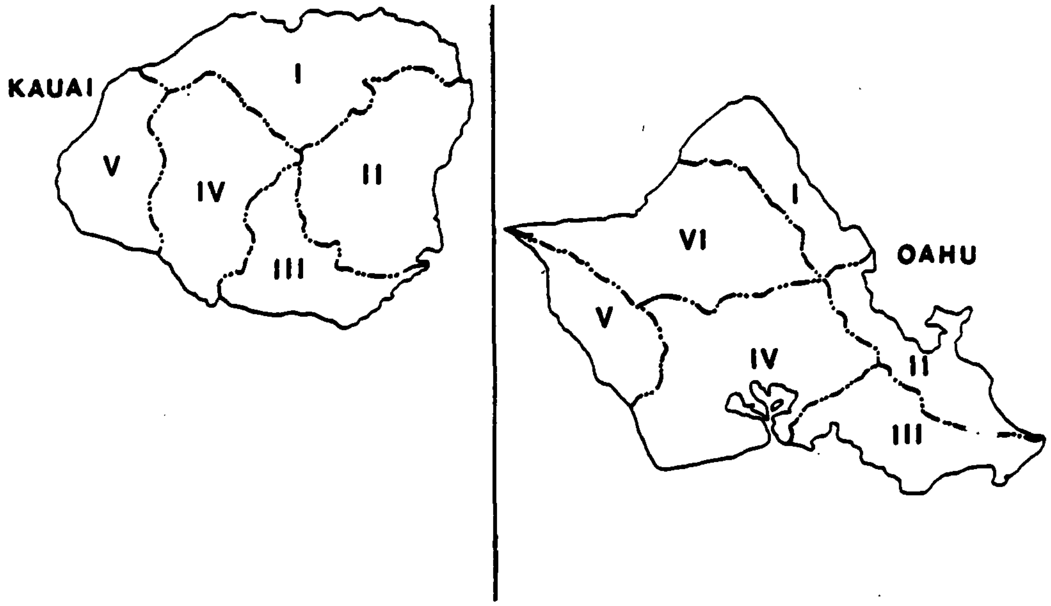
Notes: 1. Data is reported as an annual average, in inches.

2. % refers to per cent of total rainfall for each portion of the hydrologic budget within the specific Hydrographic Area.

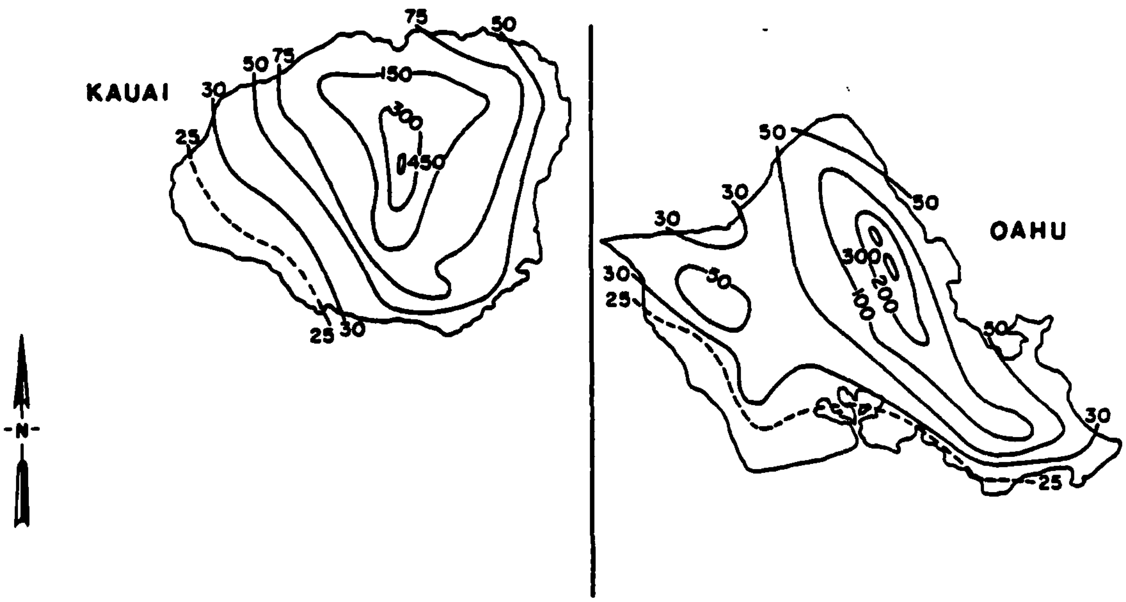
3. The Kaena Pt. STS straddles the boundary between Oahu Hydrographic Areas V and VI. Therefore, the data for these two areas has been averaged.

Source: Modified from Takasaki, 1978 and University of Hawaii, 1983

HYDROGRAPHIC AREAS AND PRECIPITATION OF KAUAI AND OAHU



Hydrographic Areas of Kauai and Oahu



Lines of Equal Annual Average Rainfall in Inches

SOURCE: TAKASAKI, 1978

may produce 16 inches of precipitation. This high figure suggests a strong erosion potential.

GEOGRAPHY

The Hawaiian Archipelago is a group of shoals, reefs and islands arranged in a linear fashion across more than 1,500 miles of the Pacific Ocean, trending from northwest to southeast (Takasaki, 1978). All of the islands are actually the exposed tops of shield volcanoes that protrude above the ocean surface. Each of the islands consists of one to five volcanic domes, usually formed by the accumulation of repeated basaltic lava flows. Of the main islands, Kauai is considered to be the oldest and Hawaii is the youngest. Although the islands are relatively small, a variety of conspicuous landforms has developed on each. Figure 3.2 is a depiction of the prominent physiographic divisions of Kauai and Oahu, modified from University of Hawaii (1983). The relief features of each of the major physiographic divisions is a result of construction (lava flow) and subsequent erosion.

TOPOGRAPHY

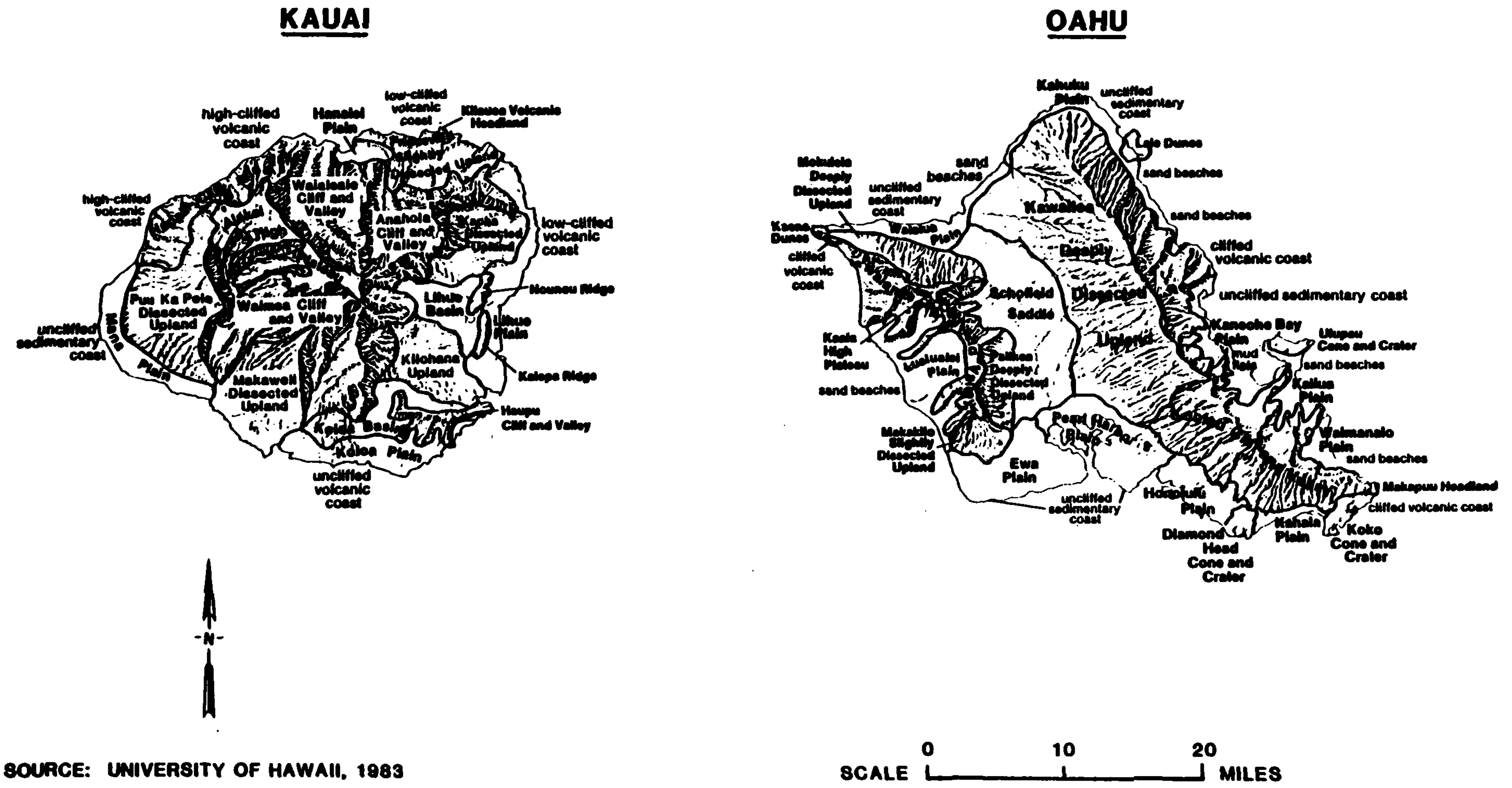
Bellows AFS

Bellows AFS is located on the Waimanalo Plain on the east shore of Oahu, where sandy beaches are the predominant physical feature. The station is located just below the promontories of the Koolau Cliff and Valley. The station's generally level terrain averages 20 feet Mean Sea Level (MSL) throughout most the base area. Relief becomes apparent along the installation's north and west boundaries where the plain meets the cliff and valley landforms. The installation's highest point, a ridge in the Keolu Hills just north of Tinker Road has a maximum elevation of 420 feet MSL.

Kaena Pt. STS

Kaena Pt. STS occupies a triangular facet on westernmost Oahu which includes small portions of three distinct physiographic divisions. The seaward portion of the station includes a small part of the Kaena Dunes area where sandy beaches with elevations averaging 20 feet, MSL are common. The upland section of the station straddles the Mokuleia Deeply Dissected Upland (north) and the Waianae Cliff and Valley (south).

PHYSIOGRAPHIC DIVISIONS OF KAUAI AND OAHU



SOURCE: UNIVERSITY OF HAWAII, 1983

These divisions are marked by steep, seaward-facing escarpments, frequently incised by gulches. A U.S. Geological Survey (USGS) monument located on the inland margin of the station records a surface elevation of 768 feet, MSL. Relief across the installation property is on the order of 750 feet and may be seen as a steep rise from the coast to the local crest of Kauokala Ridge.

Punamano AFS

Punamano AFS is situated on the northern slope of the Kawailoa Deeply Dissected Upland, just above the Kahuku Plain. The upland consists primarily of steep mountain ridges and deeply incised valleys, frequently exhibiting sheer walls. Ephemeral streams are common. Relief at the station is sharp, on the order of 360 feet. Oio Gulch is present to the west of the site and Hoolapa Gulch is located just east.

Hickam POL Facilities

The Hickam POL facilities are located on the Schofield Saddle, or central valley of Oahu. The saddle is a subdued divide between two volcanic areas where the lava flows have met or impinged. The region is level to gently sloping and ephemeral streams have formed in well incised valleys. The Waikakalaua area is located on a generally level area west of Waikele Stream where typical surface elevations are on the order of 720 feet, MSL. Relief across the site is about 120 feet and is most pronounced in the southern corner of the triangular-shaped facility. The Kipapa area is located within the valley of Kipapa Stream where typical elevations range from 315 feet MSL in the stream channel to some 480 feet MSL at the top of the valley wall along the site's western boundary. Relief is quite apparent along both valley walls and averages some 150 feet.

Kokee AFS

The Kokee AFS is situated on Kahuamaa Flat of the Alakai High Plateau, a locally featureless plain with gentle slopes and surface elevations averaging 4200 feet, MSL, on the island of Kauai. Regional relief has been formed south and west of the site by erosion and stream valley development. Relief across the installation property attains a maximum of forty feet, from west to east.

DRAINAGE

Drainage characteristics for each of the 15th ABW Satellite Installations are quite variable, as topography, construction and installation features impact drainage.

Bellows AFS

Most of Bellows AFS occupies lowlands and the windward slopes of the Keolu Hills on the east side of Oahu. Precipitation falling on the slopes moves downhill via unchannelized flow where it is intercepted by diversion structures and is directed to one of the two streams transecting the station. The primary surface water of the study area, Waimanalo Stream, extends across the approximate center of the installation, from southwest to northeast where it terminates in Waimanalo Bay. Inoaole Stream extends across the southernmost extremity of the station and also terminates in Waimanalo Bay. Bellows AFS drainage is depicted on Figure 3.3.

Kaena Pt. STS

Drainage from Kaena Pt. STS closely mirrors surface topography, flowing downslope to the north, west and south to the Pacific Ocean. No surface waters cross installation property. Figure 3.4 depicts installation surface drainage features.

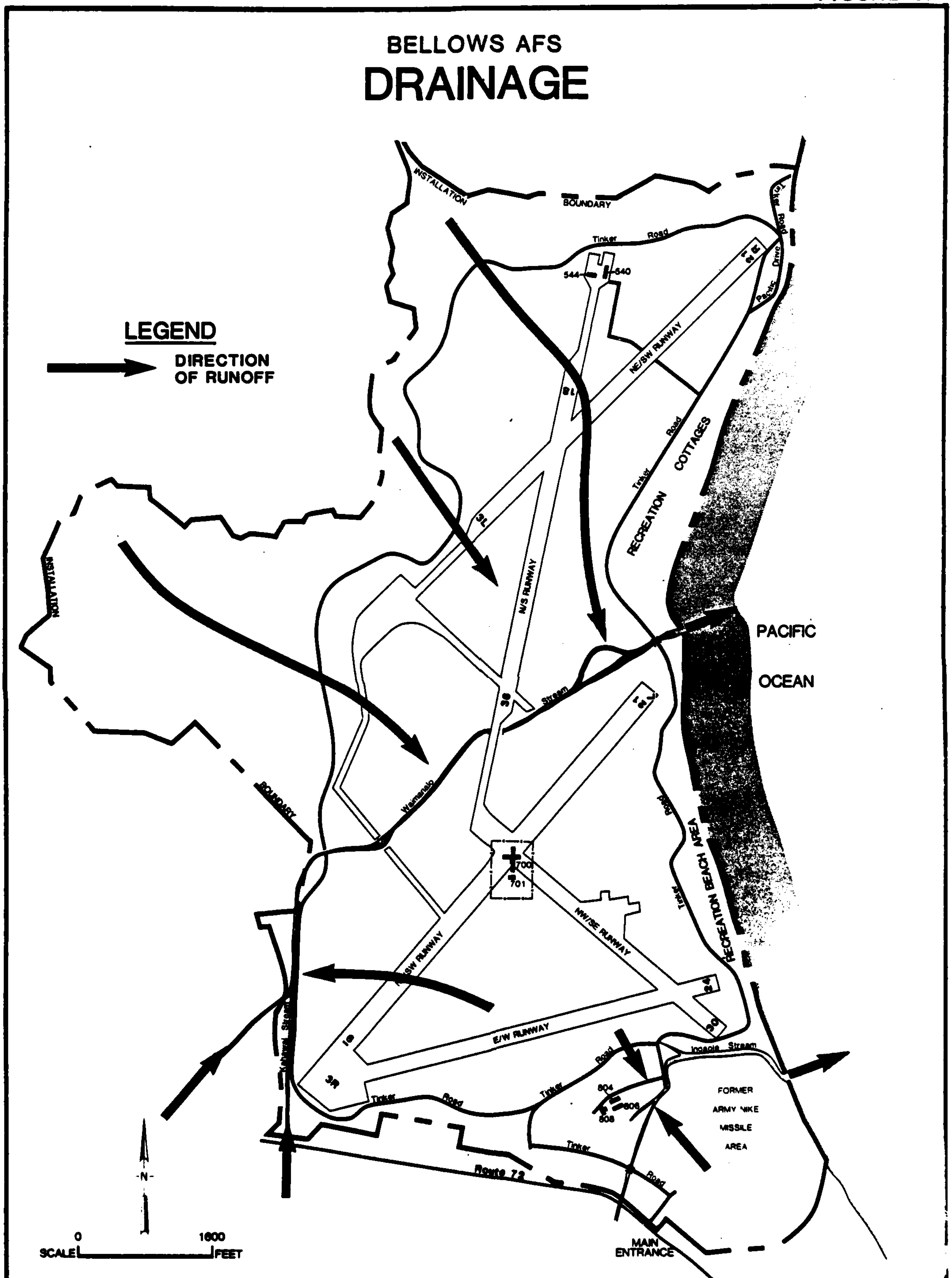
Punamano AFS

Punamano AFS occupies a highland position overlooking the Kahuku Plain. Site drainage occurs in a generally northward direction, closely following local surface topography. Runoff flowing downhill would likely be intercepted by the east-west trending stream which parallels the local toe of slope. Flow continues east, passing through the Natural Wildlife Refuge near the Town of Kahuku where it enters the Pacific Ocean. There are no surface waters on the station's property. Figure 3.5 depicts Punamano AFS drainage features.

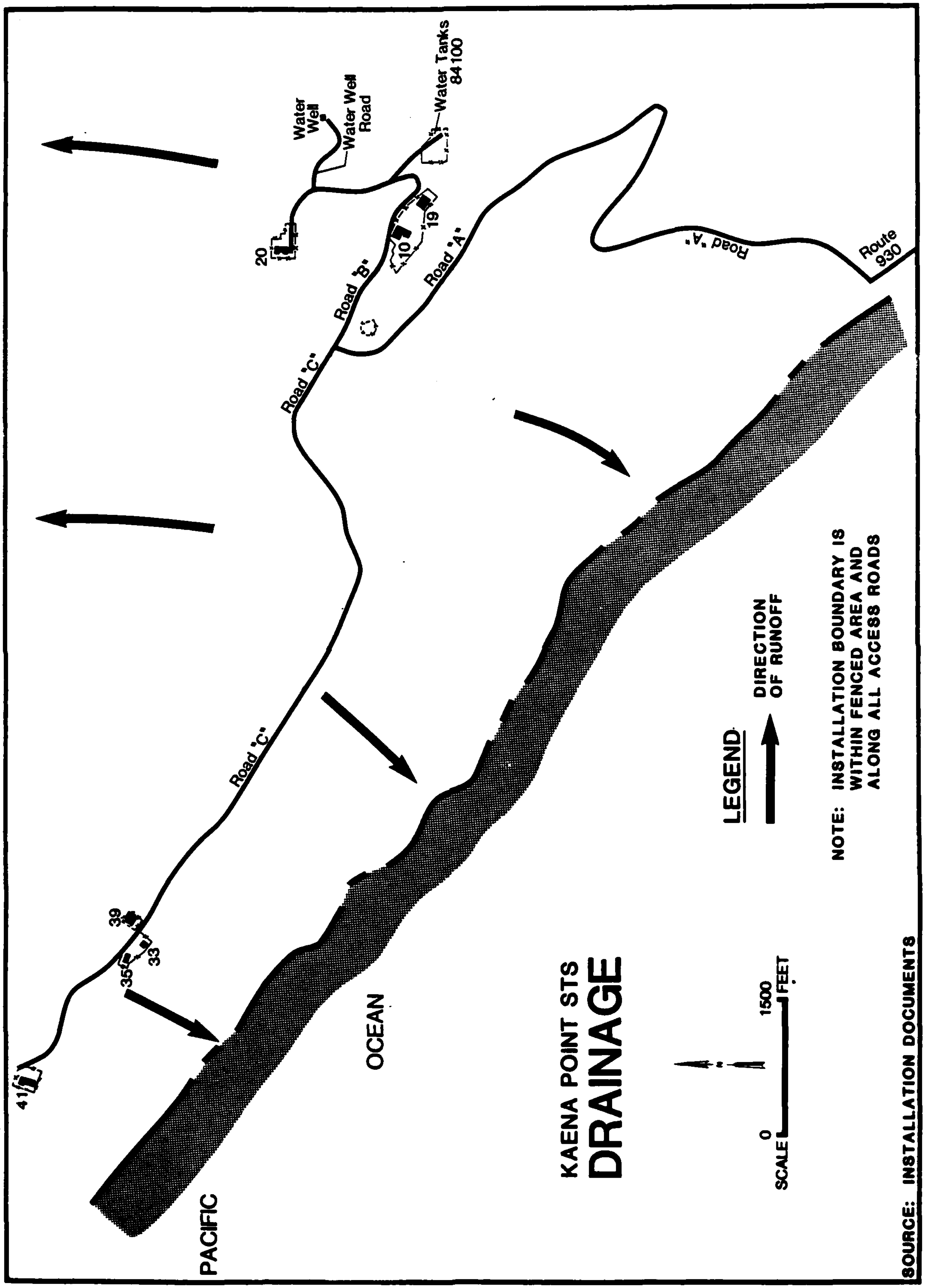
POL Storage Facilities

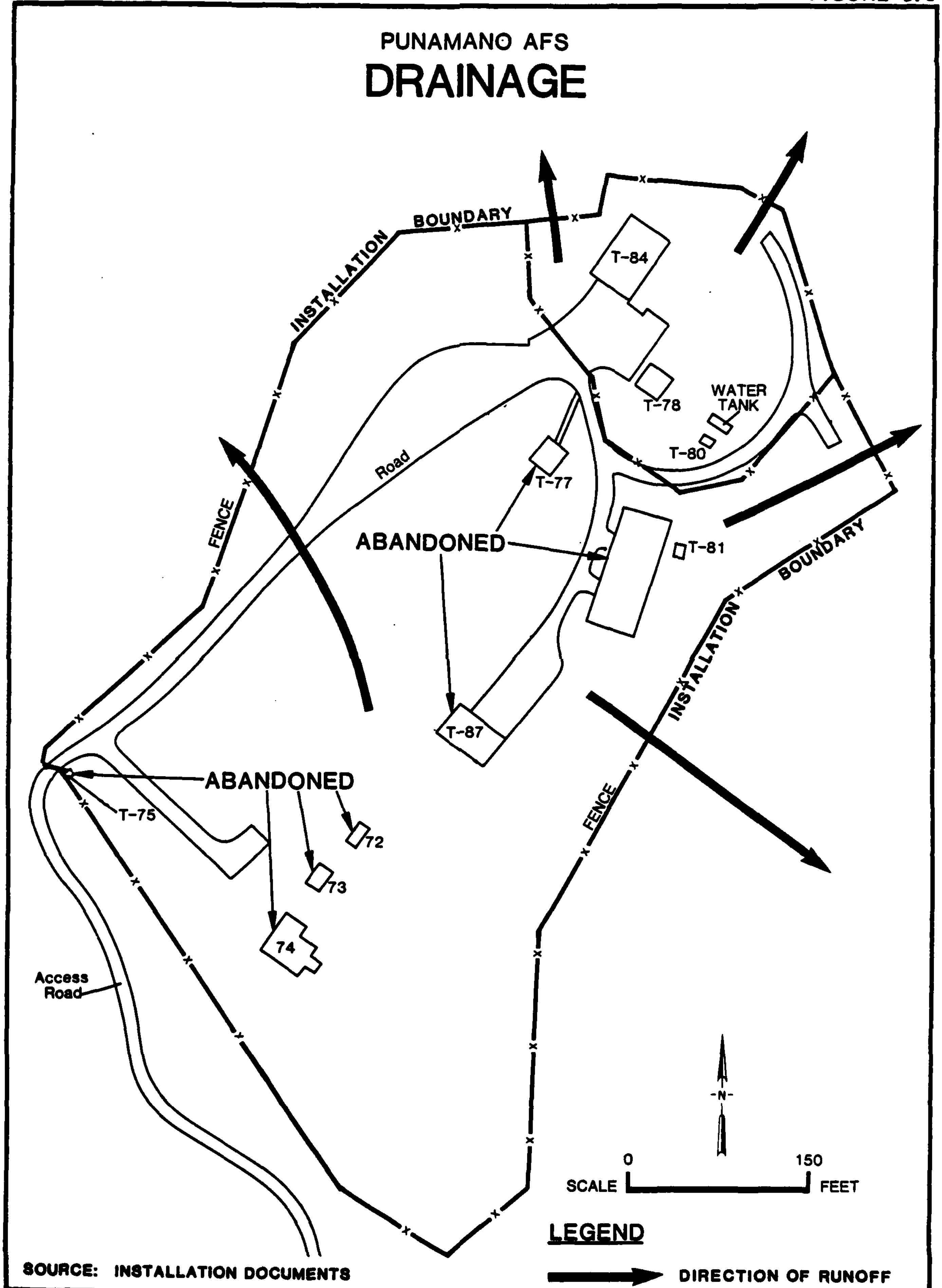
Drainage from the Waikakalaua site moves by overland flow from the north side of the installation, toward the east to the slopes above Waikele Stream or to the south to an unnamed tributary of Waikele. There are no surface waters crossing installation property.

Drainage from the Kipapa site remains within the Kipapa Stream valley and is directed to the stream. All drainage exits the site via



SOURCE: INSTALLATION DOCUMENTS


KAENA POINT STS
DRAINAGE
PACIFIC
OCEAN
Water Tanks
84100
Water Well
Water Well Road
Road "A"
Road "B"
Road "C"
Route 930
20
10
19
39
33
35
41
SCALE
0
1500
FEET
LEGEND
DIRECTION OF RUNOFF
NOTE: INSTALLATION BOUNDARY IS WITHIN FENCED AREA AND ALONG ALL ACCESS ROADS
SOURCE: INSTALLATION DOCUMENTS


PUNAMANO AFS
DRAINAGE
INSTALLATION BOUNDARY
FENCE
T-84
T-78
WATER TANK
T-80
T-77
Road
ABANDONED
T-81
T-87
ABANDONED
T-75
72
73
74
Access Road
SCALE
0
150
FEET
N
LEGEND
DIRECTION OF RUNOFF
SOURCE: INSTALLATION DOCUMENTS

Kipapa Stream, which roughly bisects the installation. Figures 3.6 and 3.7 depict the surface drainage features of the Waikakalaua and Kipapa storage areas, respectively.

POL Pipeline

The dual fuel pipeline serving the Waikakalaua and Kipapa sites is approximately 16 miles in length and crosses the channels of Waikakalaua, Kipapa, Waikele and Waiwa Streams, as well as at least four other unnamed minor watercourses. All of these streams drain to the lochs of Pearl Harbor. Northwest of Pearl City, the streams are essentially ephemeral, that is, they normally flow only when sufficient runoff is available to sustain them. South of the Pearl City area, the streams tend to be perennial, exhibiting constant flow. In the Pearl Harbor area, the pipeline crosses the Middle Loch and the Main Harbor Entrance. All of the surface waters crossed by the pipeline are located in Hydrographic Area IV (Pearl Harbor). Figure 3.8 depicts local drainage conditions along the length of the pipeline.

Kokee AFS

Kokee AFS occupies a slight rise in a generally level area. Because of this position, most surface drainage is directed to the east toward Kahuamaa Flat where it may eventually reach Kalalau Stream and be discharged to the Pacific Ocean. There are no surface waters present within the boundaries of Kokee AFS. Figure 3.9 depicts installation surface drainage features.

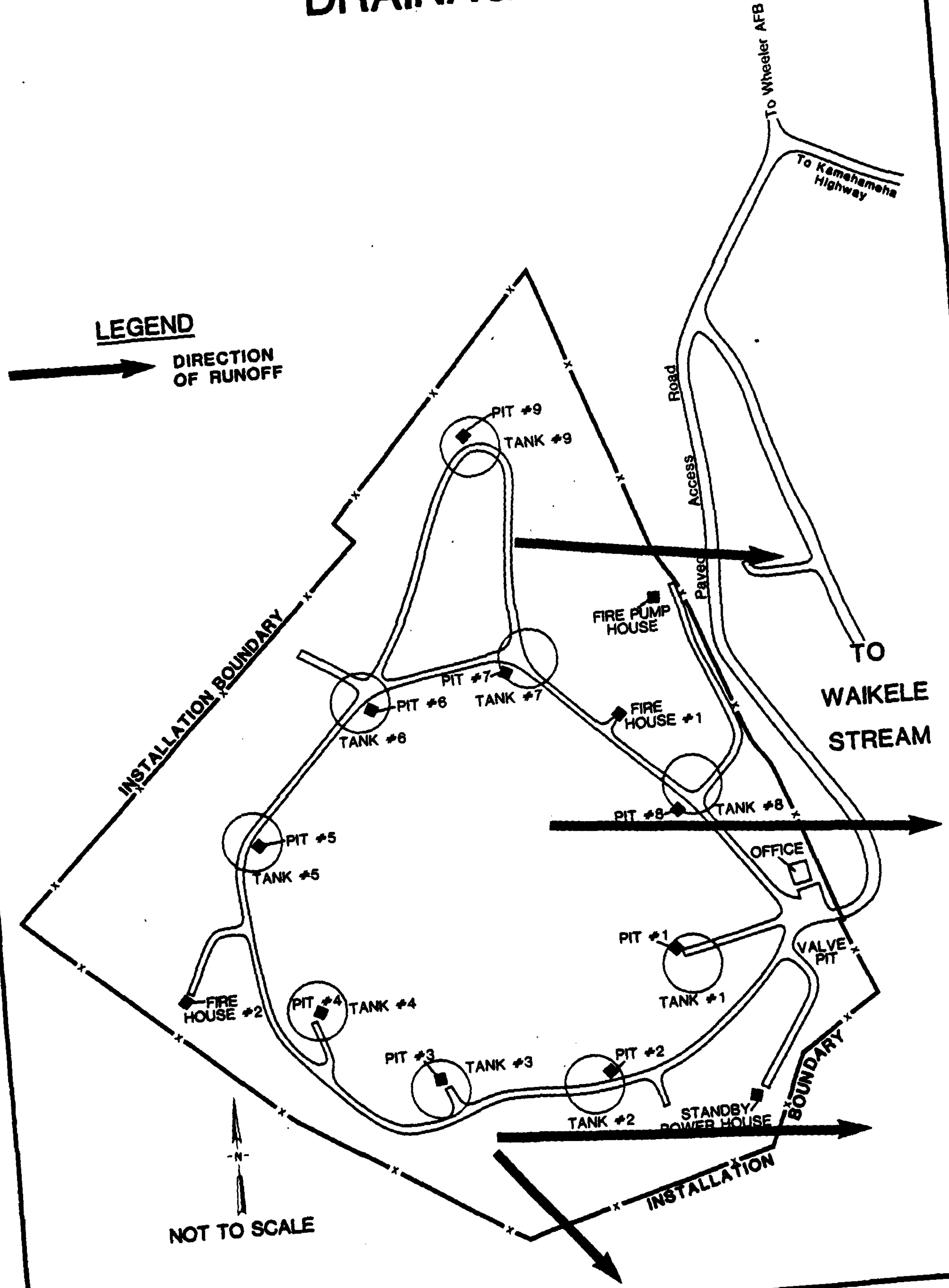
SOILS

Soils information is obtained in order to provide generalized descriptions of the basic soil types that may be present at a given site and to furnish the data essential for the completion of the HARM ratings. Data for this subsection was obtained from USDA, SCS (1972a and 1972b).

Bellows AFS

Bellows AFS soils are highly variable, including loams, clays and sands. Soils present on the east-facing slopes of the Keolu Hills are typically fine-grained and produce rapid runoff. Level and lowland soils are sandy, more permeable and may posses shallow water tables. Table 3.2 lists the seventeen soil types present at Bellows AFS and

WAIKAKALAUA POL STORAGE
DRAINAGE



SOURCE: INSTALLATION DOCUMENTS

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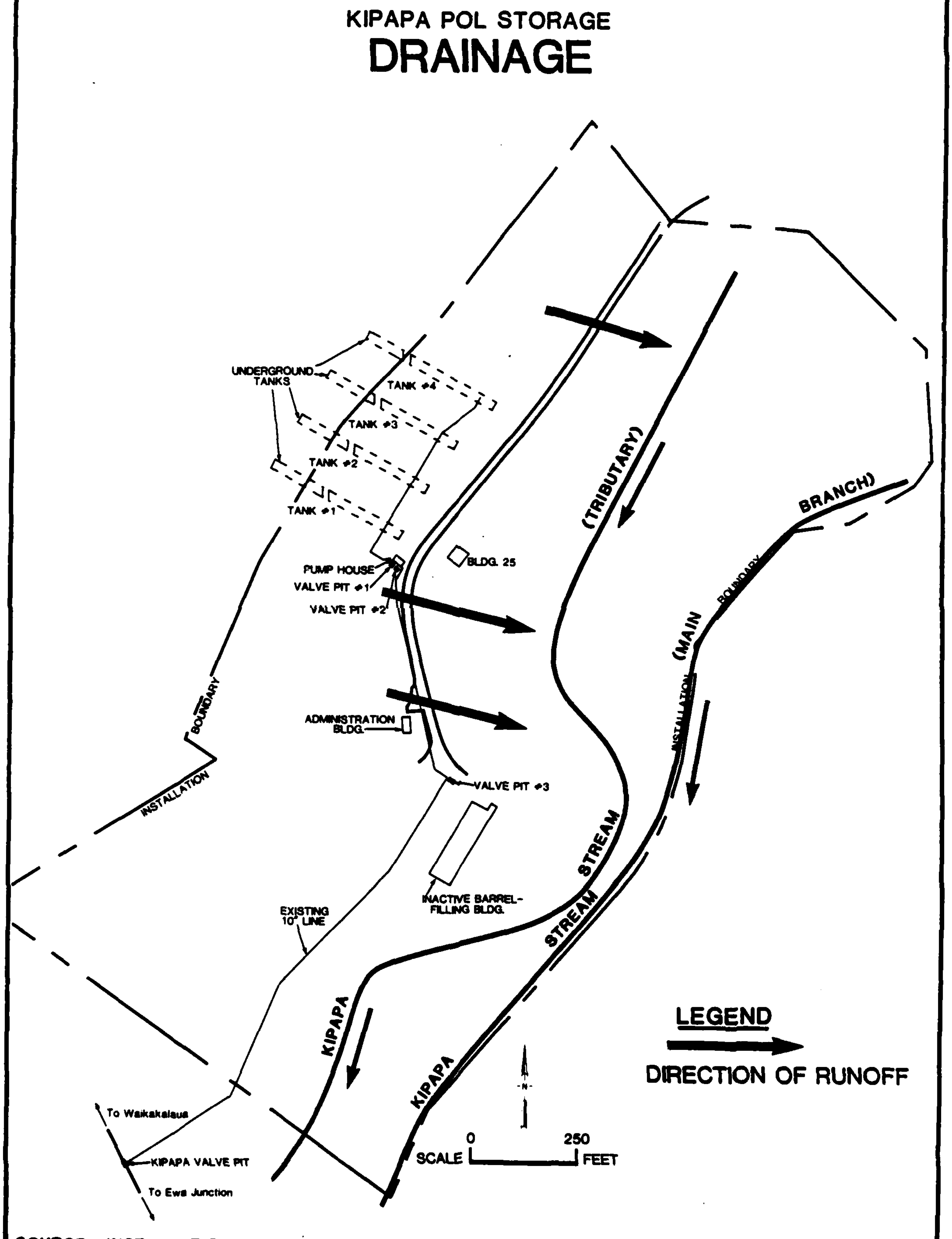
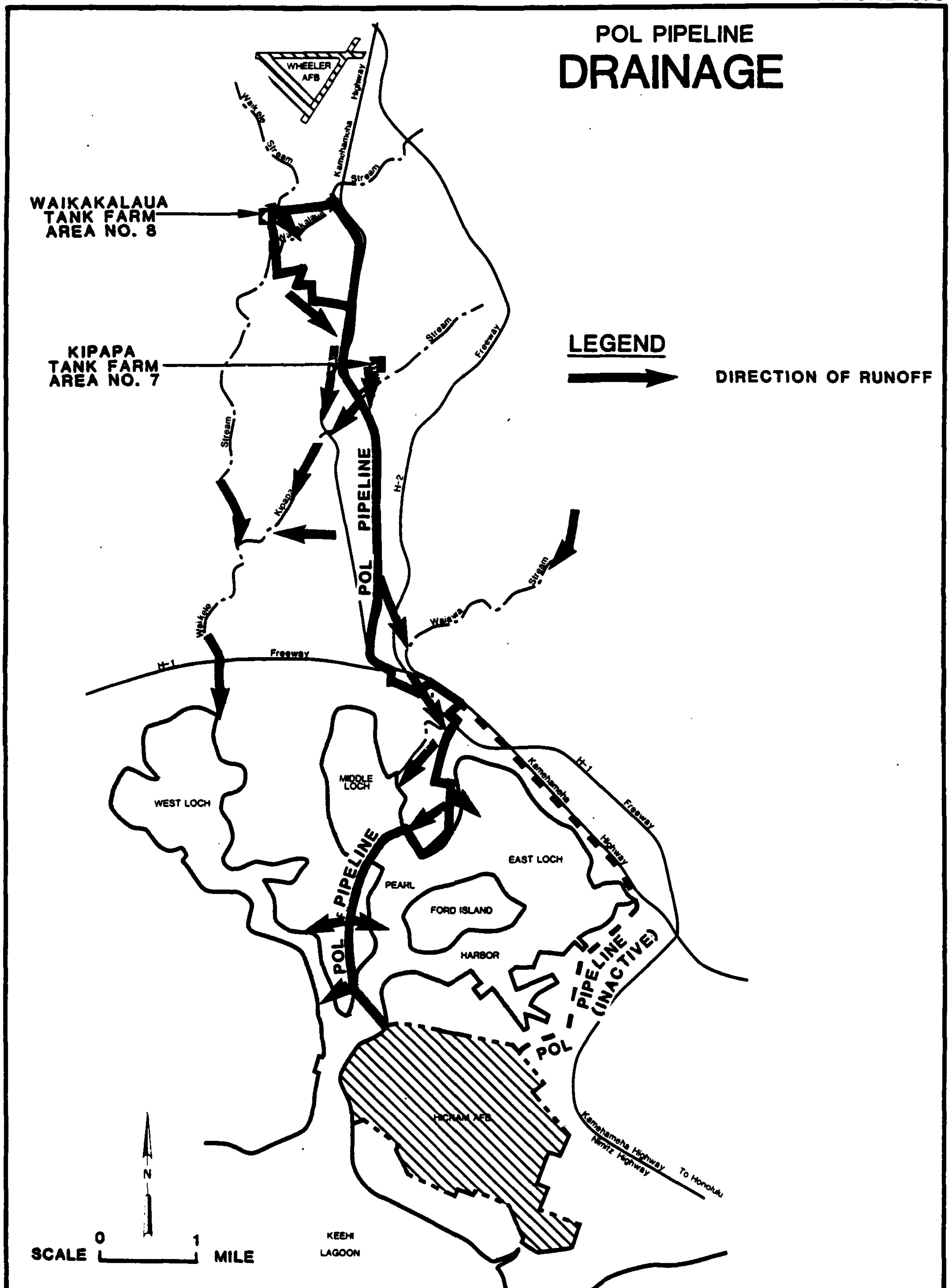
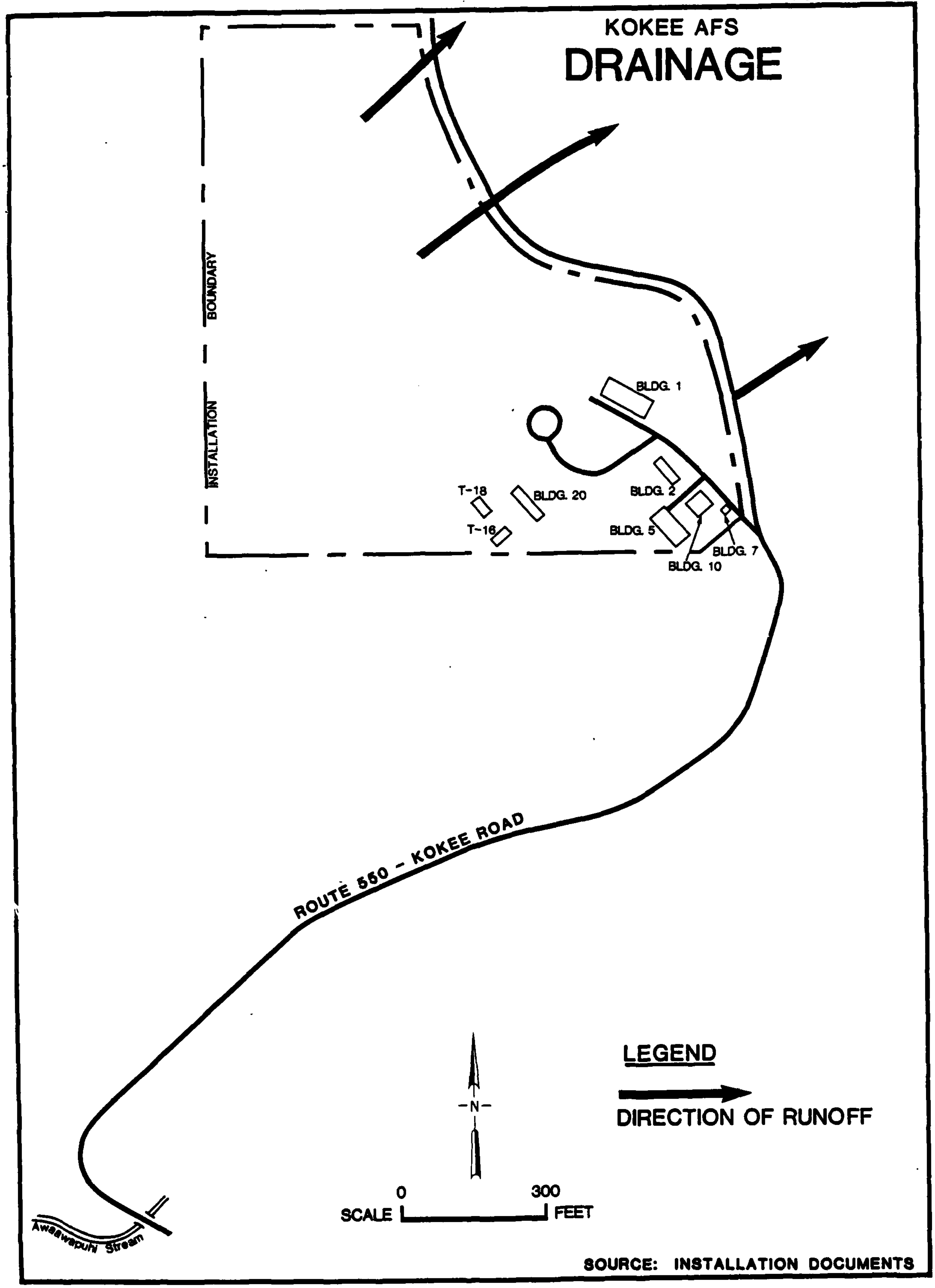


SOURCE: INSTALLATION DOCUMENTS



SOURCE: INSTALLATION DATA ; USGS TOPOGRAPHIC MAPS

FIGURE 3.9



SOURCE: INSTALLATION DOCUMENTS

ES ENGINEERING-SCIENCE

TABLE 3.2
BELLOWS AIR FORCE STATION SOILS

Map Symbol	Unit Description	USDA Texture (Major Fraction)	Thickness (Inches)	Unified Classification[1] (Major Fraction)	Permeability (Inches/hour)	Waste Facility Use Constraints
ALF	Alaeloa silty clay, 40-70 per cent slopes	Silty clay	Varies	MH	2.0 - 6.3	Severe. Rapid runoff. High erosion hazard.
BS	Beaches	Sand and gravel	Varies	SP, SW, GW	20 +	Severe. Low runoff. Shallow water table.
CR	Coral outcrop	Coral, concentrated calcarceous sand	Varies	SP	Unknown	Severe. Shallow water table.
EmA	Ewa silty clay loam, 0-2 percent slopes	Silty clay loam	20 - 50	ML, CL	0.63 - 2.0	Severe. Underlain by coral. Slow runoff.
FL	Fill	Miscellaneous Fill	Varies	SP, ML, CL, etc.	variable	Severe. Shallow water table.
HeA	Haleiwa silty clay, 0-2 percent slopes	Silty clay	60	MH - CH	0.63 - 2.0	Moderate. May flood.
JaC	Jaucas sand, 0-15 percent slopes	Sand	60	SP	6.0 - 20.0	Severe. Shallow water table.
KfB	Kaloko Clay, noncalcareous	Clay, silty clay	60	CH	0.06 - 0.2	Severe. Shallow water table.
KlbC	Kawaihapai stoney clay loam, 0-15 percent slopes	Clay loam, gravelly clay loam	54	CL	0.63 - 2.0	Moderate. May flood.
KtC	Kokohahi Clay, 6-12 percent slopes	Clay, gravelly clay	44	CH	0.06 - 0.63	Moderate to severe. Wetness - poorly drained.
KTKE	Kokohahi very stony clay, 0-35 percent slopes	Clay, gravelly clay	44	CH	0.06 - 0.63	Moderate to severe. Wetness - poorly drained.
Ms	Mokuleia loam	Clay loam, loam, fine sandy loam, sand	50	CL, SM, SP	0.63 - 20.0	Severe. Erodes easily.
Mt	Mokuleia clay loam	Clay loam, loam, fine sandy loam, sand	50	CL, SM, SP	0.63 - 20.0	Severe. Erodes easily.

TABLE 3.2 (Continued)
BELLOWS AIR FORCE STATION SOILS

Map Symbol	Unit Description	USDA Texture (Major Fraction)	Thickness (Inches)	Unified Classification[(1)] (Major Fraction)	Permeability (Inches/hour)	Waste Facility Use Constraints
PkB	Pohakupu silty clay loam, 0-8 percent slopes	Silty clay loam	76	MH	2.0 - 6.3	Moderate. Medium runoff.
PYD	Papaa clay, 6-20 percent slopes	Clay, silty clay loam	40	CL, CH	0.06 - 0.63	Moderate. Medium runoff.
PYF	Papaa clay, 35-70 percent slopes	Clay, silty clay loam	40	CL, CH	0.06 - 0.63	Severe. Rapid runoff. High erosion hazard.
rSY	Stony steep land, 40-70 percent slopes	Gravel, boulders, rock outcrops	Varies	Not estimated	Not estimated	Severe. Frequent outcrops. Rapid runoff.

(1) See Appendix D for further information.

Source: U.S. Department of Agriculture, Soil Conservation Service, 1972.

summarizes their major characteristic relative to this investigation. Figure 3.10 depicts the approximate distribution of the installation soils.

Kaena Pt. STS

Three soil types have been mapped at Kaena Pt. STS, all of which are related to the parent bedrock. Bedrock (SCS map symbol: rRK) is present on the highest elevations and may be overlain locally by thin occurences of sandy soils, usually no more than one or two feet thick. The slopes around the installation are covered by Stony Steep Land (SCS map symbol: rSY) where grades range from 40 to 70 percent. This unit is composed of gravel, cobbles, boulders, etc. and rock outcrops are common. The steepness of the slopes tends to promote rapid runoff. The last unit to be identified in the Kaena Point area is Stony Colluvium (SCS map symbol: rRO). This unit is primarily the talus that accumulates at the base of cliffs as a result of unchannelized flow or simple downslope movement under the influence of gravity. The unit is composed of coarse particles, most notably gravel, cobbles and boulders. All three soil units possess very high permeabilities locally.

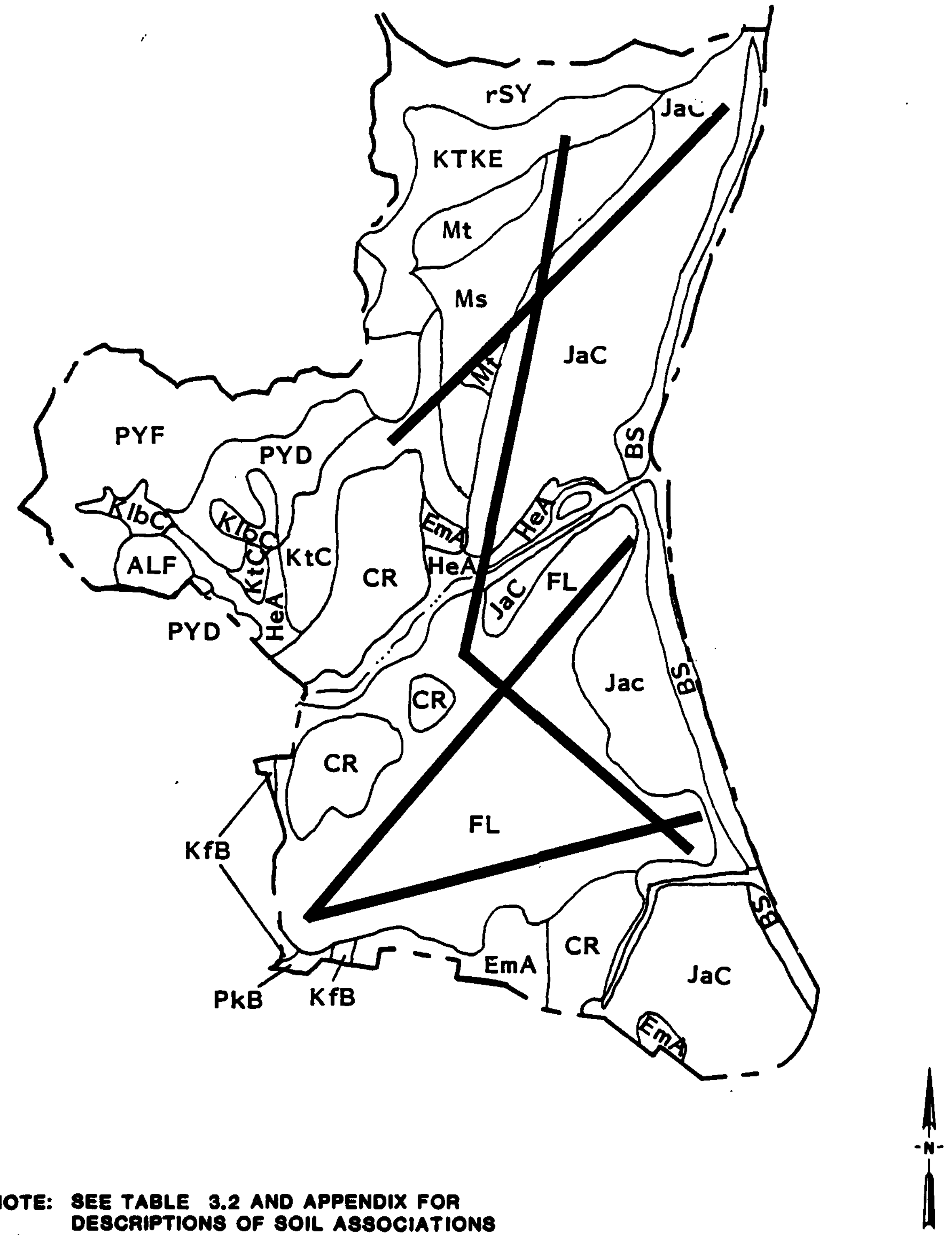
Punamano AFS

The Kemoo Silty Clay (SCS mapping unit: KpD) with 12 to 20 percent slopes is the primary soil type present at Punamano AFS. This is a residual soil developed from the weathering of the underlying igneous bedrock. Its topographic expression is a gently sloping to steep surface. Typically, the upper soil is a 12-inch thick section of silty clay overlying a 55-inch thick blocky clay or silty clay. The substratum is a weathered rock. Unit permeability is described as moderate to moderately rapid and the runoff potential is "medium". The erosion hazard is moderate and is related more to surface slope than soil structure. The Kemoo Series is more susceptible to erosion hazard with increasing slopes.

POL Storage Facilities

The principal soil type underlying the Waikakalaua site is the Wahiawa silty clay (SCS map symbol: WaA). The material is common to generally level terrain and its profile averages sixty inches in thickness. Its permeability ranges from 2.0 to 6.3 inches per hour (moderately rapid) and runoff is described as slow.

BELLOWS AFS
SOIL ASSOCIATIONS



NOTE: SEE TABLE 3.2 AND APPENDIX FOR DESCRIPTIONS OF SOIL ASSOCIATIONS

SOURCE: USDA, SCS, 1972

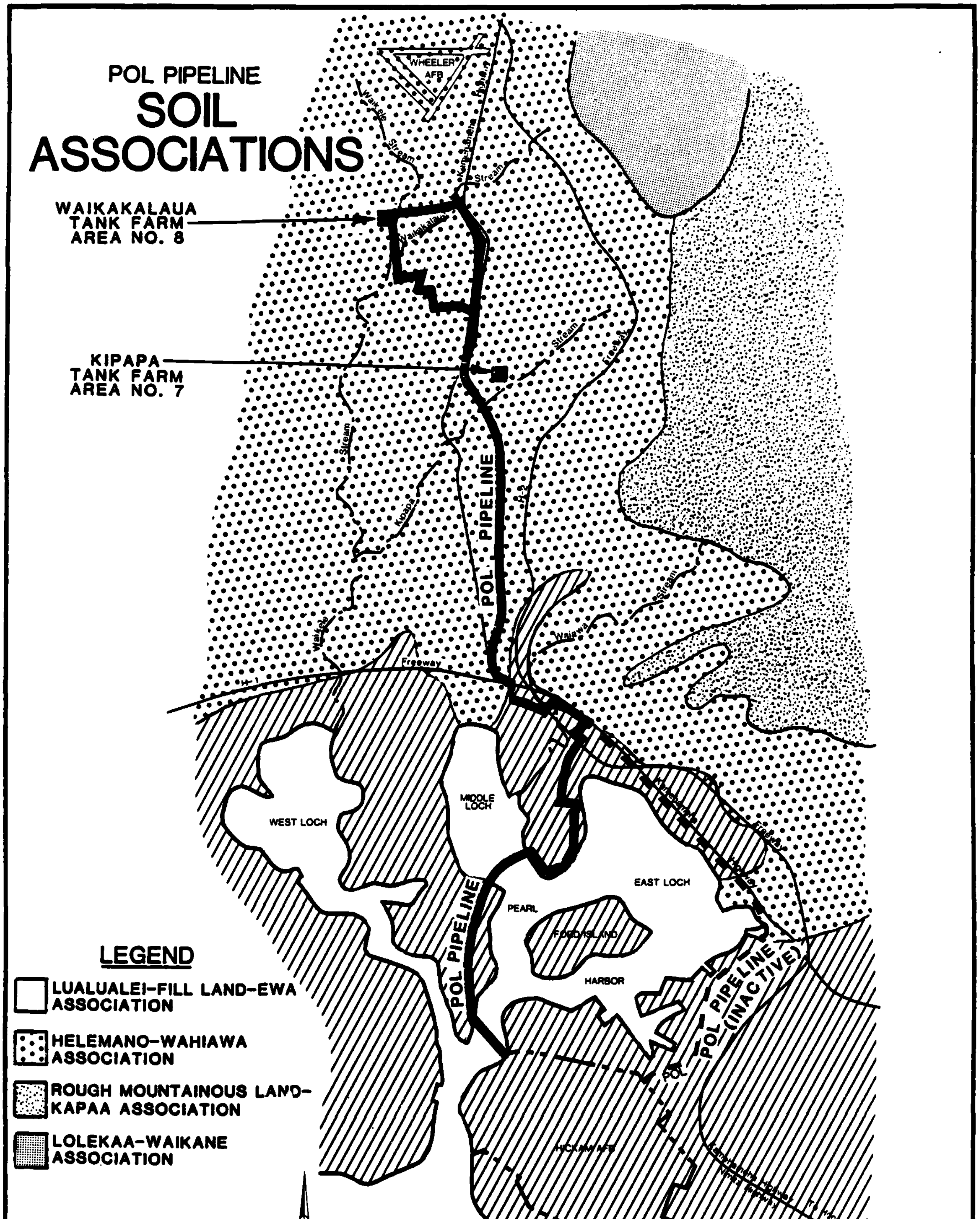
SCALE 0 1600 FEET

Two soil types have been mapped at the Kipapa site: Helemano silty clay (SCS map symbol: HLMG) is present on the slopes and escarpments facing the valley and Haleiwa silty clay (SCS map symbol: HeA) occupies the level lowlands as a narrow band straddling Kipapa Stream. The Helemano soils are present on the very steep grades where slopes range from 30 to 90 percent. The soil profile is relatively thin, varying from 25 to 60 inches in thickness and is underlain by bedrock. Permeability is described as moderate and runoff is very rapid. The unit is subject to erosion. The Haleiwa soils have a slight surface slope on the order of 0 to 2 percent. Their typical profile is sixty inches thick. Haleiwa soils are poorly drained and usually possess shallow water tables. They may flood on occasion due to their proximity to Kipapa Stream and the narrow channel they occupy.

POL Pipeline

The pipeline serving the Waikakalaua and Kipapa sites is approximately 16 miles long and traverses two major soil associations. The upland area where the northern one-half of the line is located is dominated by the Helemano-Wahiawa Association. This group of soils is a well-drained fine-textured residuum common in level to moderately sloping uplands. They occur as a broad band dissected by frequent steep gulches and stream valleys. The soils are most often described as silty clays with a weathered rocky substratum. This permeability is moderately rapid and runoff potential is characterized as slow to very rapid, depending on the local topography.

The southern extent of the fuel pipeline crosses the Lualualei-Fill Land-Ewa Association. This group of soils consists of well-drained fine and moderately fine-textured soils on alluvial fans and in drainage ways of the southern Oahu Coastal Plain. Their topographic expression is usually a nearly level to moderately sloping surface occasionally interrupted by stream channels. The materials present include silt, clay and sand; the clays may be plastic and crack upon dessication. They are underlain by coral, gravel, sand or clay at depths below forty inches. Their permeability ranges from very slow to moderately rapid and the runoff potential varies from slow to medium. The erosion potential is high where clays predominate. The distribution of the major soil associations relative to the pipe alignment is shown on Figure 3.11.


POL PIPELINE
SOIL
ASSOCIATIONS
WAIKAKALAUA
TANK FARM
AREA NO. 8
KIPAPA
TANK FARM
AREA NO. 7
WHEELER AFB
POL PIPELINE
WEST LOCH
MIDDLE LOCH
EAST LOCH
PEARL
HARBOR
FORD ISLAND
POL PIPELINE (INACTIVE)
HICKAM AFB
KEEHI
LAGOON
Freeway
LEGEND
LUALUALEI-FILL LAND-EWA ASSOCIATION
HELEMANO-WAHIAWA ASSOCIATION
ROUGH MOUNTAINOUS LAND-KAPAA ASSOCIATION
LOLEKAA-WAIKANE ASSOCIATION
N
SCALE 0 1 MILE
SOURCE: USDA, SCS, 1972

Kokee AFS

The principal soil type underlying the Kokee AFS is the Kokee silty clay loam (SCS map symbol: KSKE). These soils are residual, having developed from the weathered basic igneous bedrock. The unit typically occupies level to undulating uplands where slopes range from 0 to 35 percent. The USDA texture is described as silty clay loam or a silty clay overlying saprolite (weathered rock). The typical profile is 42 inches thick. Permeability ranges from 2.0 to 6.3 inches per hour and the runoff potential is described as medium.

GEOLOGY

Information describing the geology of Oahu and Kauai Islands has been obtained from Logan and Lum (1966); MacDonald, et al. (1960); Stearns (1946/1967 and 1974), and University of Hawaii Department of Geography (1983). Additional information has been obtained from interviews with U.S. Geological Survey scientists.

Oahu

The geology of Oahu includes Recent and Pleistocene unconsolidated, consolidated materials and members of the Honolulu and Kolekole volcanics. These are separated from the older Koolau, Kailua and Waianae volcanic series by erosional unconformities. Table 3.3 lists the principal geologic units of the island of Oahu and Figure 3.12 depicts the distribution of these significant rocks.

Bellows AFS

Two major geologic units are reported to be present in the Bellows AFS study area are shown in Figure 3.13. In the lowlands adjacent to Waimanolo Bay, generally unconsolidated materials including beach sand, younger dune sand and older dune sand of Quaternary age predominate. Young alluvium is present, especially near the channel of Waimanalo Stream. The moderate slopes just above the airfield area are overlain by younger alluvium which has washed downgrade. The upland areas of the station are underlain by lavas of the Koolau Volcanic Series.

Kaena Pt. STS

The geology of the Kaena Pt. STS is dominated by basalts of the Waianae Volcanic Series. This unit consists of over 6000 feet of aa (aa is massive, dense rock) andesite flows in the upper section and

TABLE 3.3

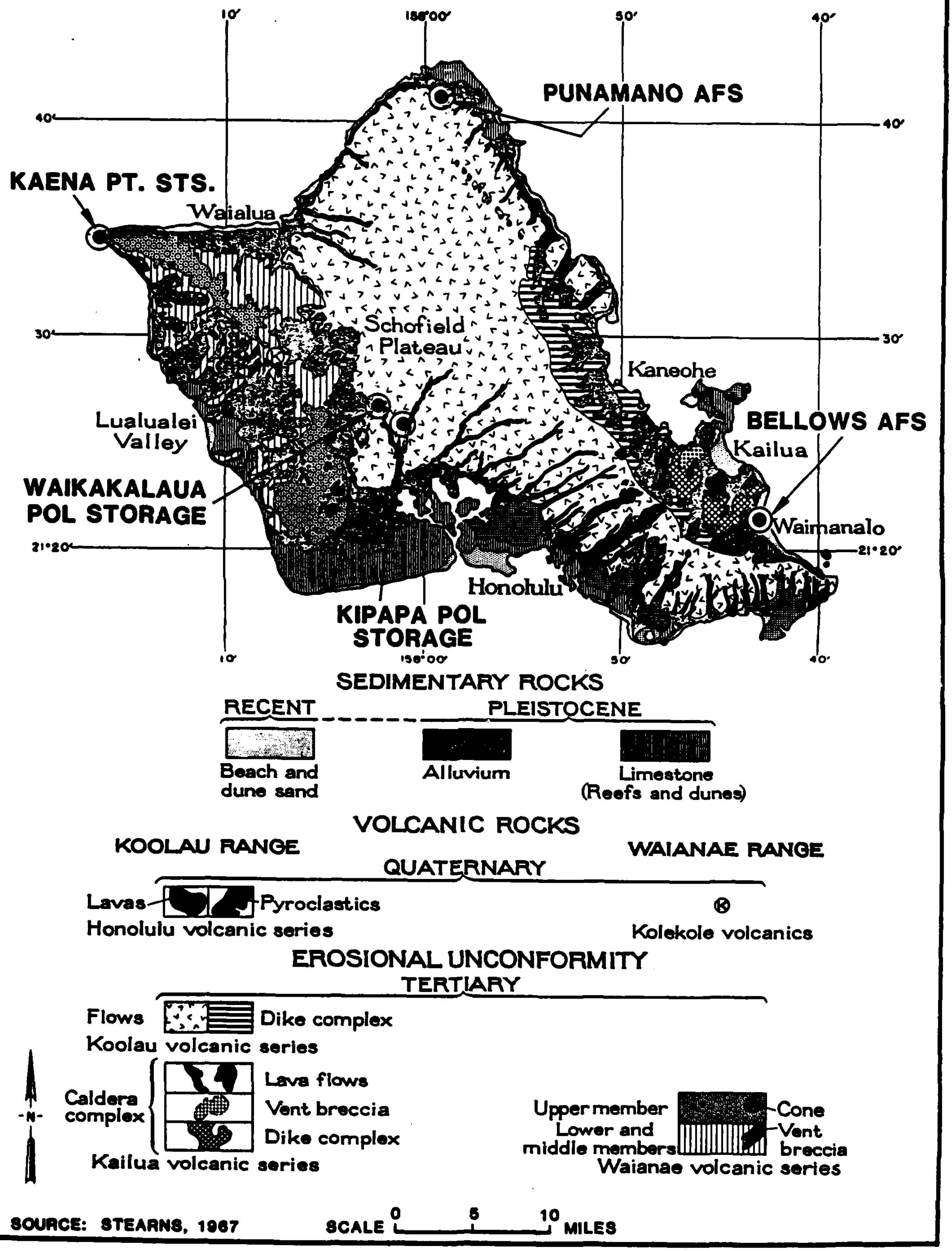
STRATIGRAPHIC ROCK UNITS ON THE ISLAND OF OAHU

Age	Rock Assemblage: Sedimentary Rocks	Rock Assemblage: Volcanic Rocks
Recent	Coral fills, younger alluvium and unconsolidated beach and dune sand	Younger members of the Honolulu volcanic series
Pleistocene	Older alluvium, lithified dunes, and emerged marine limestones chiefly coralliferous Great Erosional Unconformity	Older members of the Honolulu volcanic series and the Kolekole volcanics
Pliocene		Koolau and Kailua volcanic series Erosional unconformity Waianae volcanic series: Upper member, Middle member, Lower member

Source: Stearns, 1967

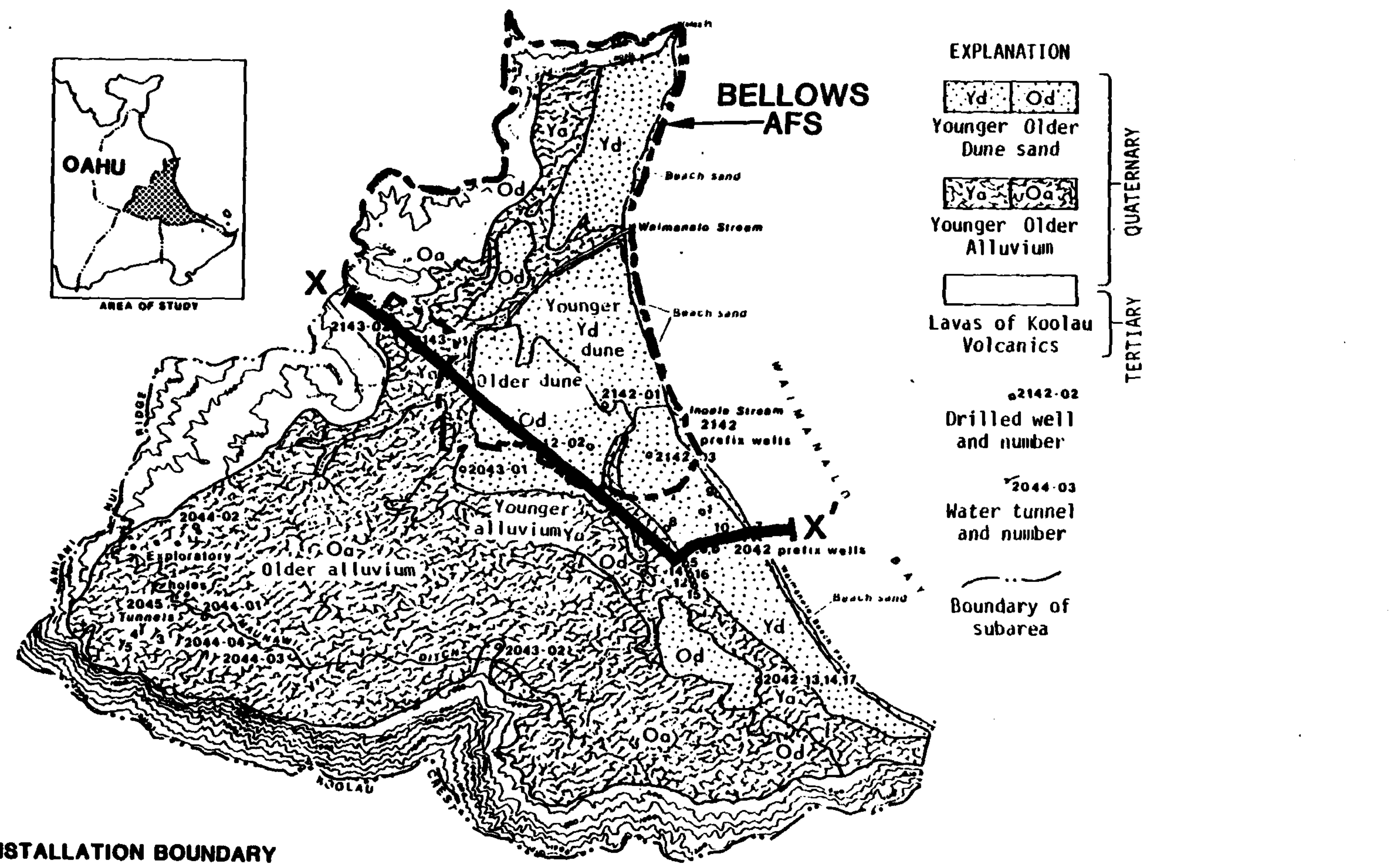
FIGURE 3.12

GEOLOGIC MAP OF THE ISLAND OF OAHU



SOURCE: STEARNS, 1967

HYDROGEOLOGICAL MAP OF WAIMANALO AREA



SOURCE: TAKASAKI AND MINK, 1982

NOTE:
(CROSS-SECTION X-X' DEPICTED ON FIGURE 3.19)

thin-bedded pahoehoe in the older members. Locally, the rock has weathered to form sandy, gravelly soils generally no more than a few feet in thickness.

Punamano AFS

Lava flows of the Koolau Volcanic Series dominate the geology of the Punamano AFS area. The Koolau Series is reported to have an exposed thickness of approximately 3000 feet and consists primarily of thin-bedded pahoehoe and aa with small amounts of ash. Deposition is believed to have been through narrow fissures, without large-scale flows characteristic of lava fountains.

POL Storage Facilities

The Hickam POL Facilities are underlain by basalts of the Koolau Volcanic Series. The Koolau is a relatively flat-lying sequence of aa, clinker and pahoehoe (clinker is a brecciated material occurring above and below the aa and pahoehoe is a smooth vesicular lava). Definable layers are usually ten feet thick or less. The material seldom extends more than a few hundred feet laterally. The vertical section frequently weathers to depths exceeding one hundred feet with resistant boulders occasionally present. A silty clay saprolite is typically the product of weathering activity.

POL Pipeline

The northern extent of the pipeline is dominated by the Koolau Volcanic Series, described above. The southern extent of the pipeline, in the Pearl Harbor area, is underlain by sedimentary materials which include dune sand, alluvium, coral and limestone, collectively known as "caprock." The caprock reaches a maximum thickness of about 1000 feet (Takasaki, 1977) at the coast and overlies the Koolau materials.

Kauai

The geology of the island of Kauai is also dominated by igneous rocks derived form volcanic activity. The principal geologic units of Kauai are summarized on Table 3.4. Their distribution is shown on Figure 3.14.

Kokee AFS

Kokee AFS is underlain by rocks of the Napali Formation. The typical Napali column is that of a 2700+ foot-thick sequence of repeated

TABLE 3.4

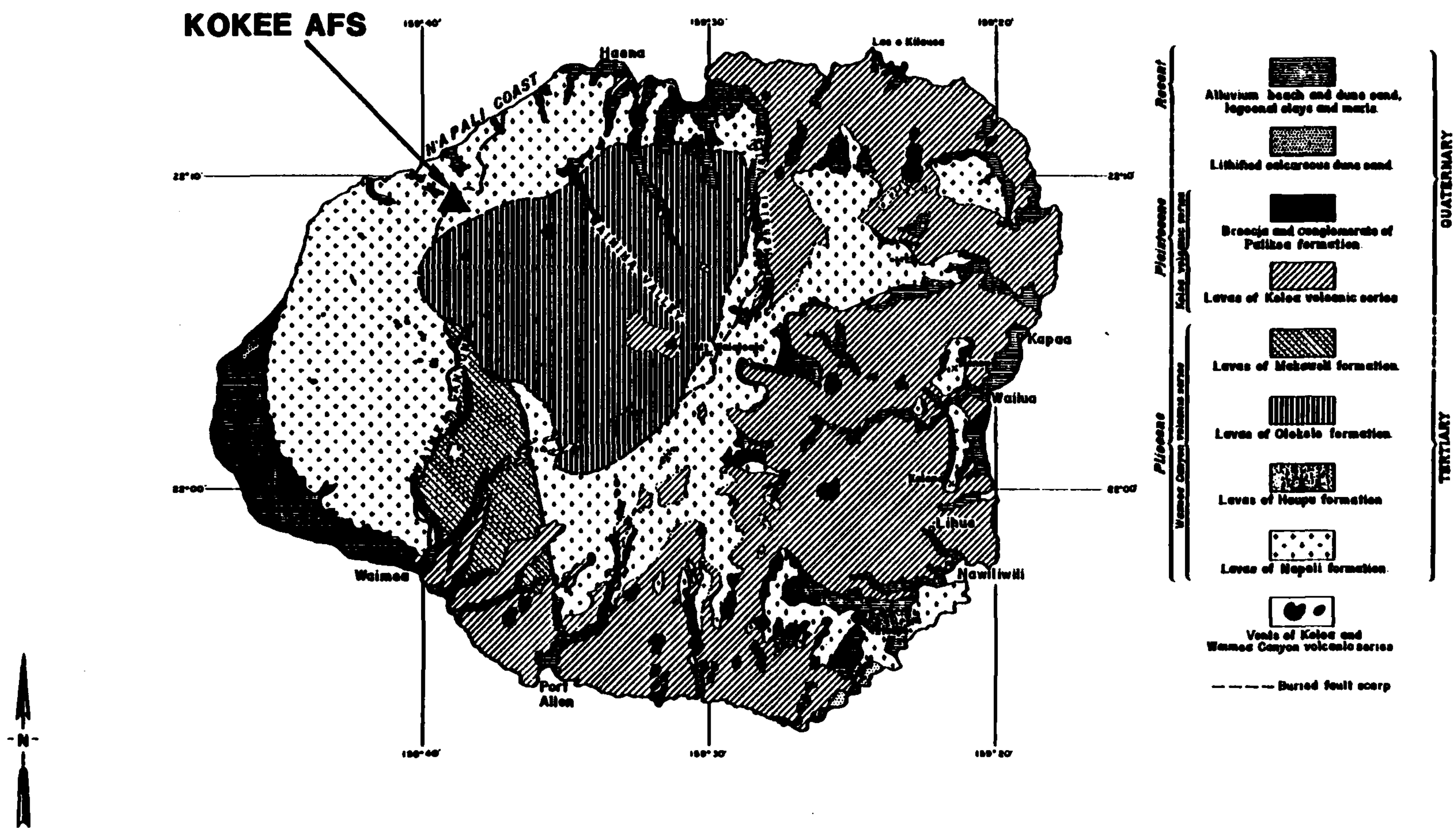
STRATIGRAPHIC ROCK UNITS ON THE ISLAND OF KAUAI

Age	Rock Assemblage: Sedimentary Rock	Rock Assemblage: Volcanic Rock	
Recent	Beach and dune sand and alluvium		
	Local unconformity		
Pleistocene	Older alluvium and lithified dune sand; lagoon deposits of Mana Plain		
	Local unconformity	Koloa volcanic series; aa and pahoehoe lava flows of nephelinite, picrite-basalt, basanite, and alkalic olivine basalt, with some intercalated ash and tuffaceous soil beds, cinder cones at the vents, and a tuff cone at Kilauca Bay.	
	Palikea formation: poorly sorted breccia sorted breccia and poorly to moderately sorted conglomerate at the base of, and and intercalated with, the rocks of the Koloa volcanic series		
Major erosional unconformity			
Pliocene	Mokuone member of the Makaweli formation; poorly sorted breccia at the base of, and moderately sorted conglomerate interbedded with, the lavas of the Makaweli formation.		Makaweli formation; aa and pahoehoe lava flows accumulated in a graben on the southwest side of the Kauai shield volcano.
			Olokele formation; thick massive flows accumulated in a broad caldera at the summit of the Kauai shield volcano.
		Waimea Canyon volcanic series: tholeitic basalt, olivine basalt, and oceanite lavas, with a little hawaite (andesine andesite) in its uppermost part.	Haupu formation; thick massive flows accumulated in a large pit crater on the southwest slope of the Kauai shield volcano.
			Napali formation: the thin-bedded pahoehoe and aa flows forming the Kauai shield volcano and dipping outward at angles of 5-10" in all directions from the caldera boundry.

Source: Stearns, 1967

FIGURE 3.14

GEOLOGIC MAP OF THE ISLAND OF KAUAI



SOURCE: STEARNS, 1967

SCALE 0 3 6 MILES

ES ENGINEERING-SCIENCE

thin flows of basalt that have accumulated on the flanks of the kauai shield volcano.

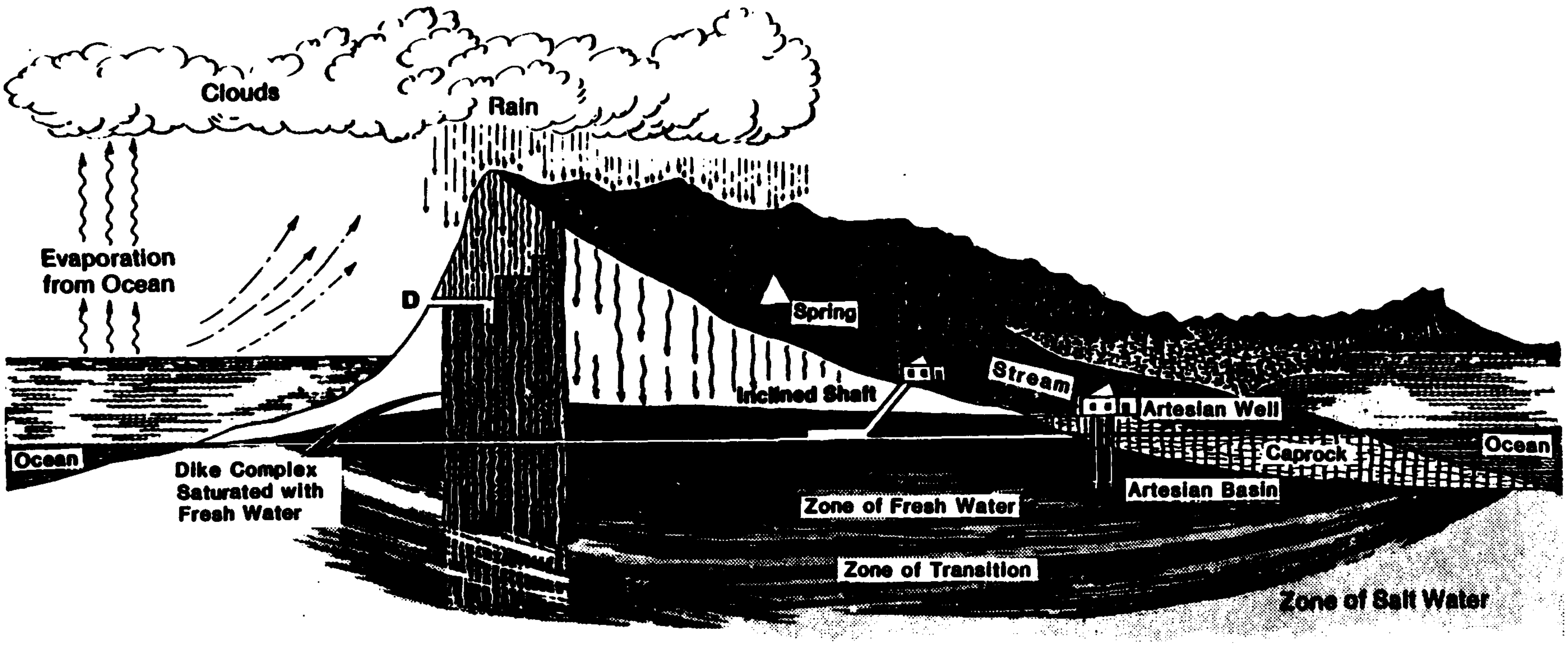
GROUND-WATER RESOURCES

Information describing the ground-water resources of the study areas has been obtained from the Board of Water Supply (1980 and 1982); Burt (1979); Division of Water and Land Development (1964); Hawaii Water Authority (1959); Mink (1980); Nakahara (1978); Rosenau, et al. (1971); State Water Commission (1979); Takasaki (1974, 1977 and 1978) and Takasaki and Mink (1982). Additional data was collected by interviewing USGS scientists and from searches of USGS files.

Oahu

The principal source of ground water in Hawaii is precipitation falling on the slopes and uplands of the island. The meteoric water infiltrates downward into the thousands of thinly bedded (ten feet thick or less) gently sloping basaltic lava flows that comprise most of the island. Numerous voids exist in these flows including those created by openings between flow sections, clinker, shrinkage joints, fractures, lava tubes and gas vesicles, making the volcanic rocks very permeable. In some areas, linear vertical intrusions called dikes are present. These dikes are typically dense, thin and usually of very low permeability which restricts the local flow of ground water. Dike complexes are those zones where individual dikes make up 10 percent or more of the total rock volume present. These complexes are important to the study of island ground water as they create "high level" water bodies behind the natural dams created by the dikes. An idealized cross section of ground-water conditions in Oahu is presented as Figure 3.15. Dike impounded ground water is present in large discreet bodies on both the east and west coasts of Oahu. In the approximate center of the island, a "high level" water body exists due to flow restrictions created by geologic structural discontinuities. The high level water body recharges the adjacent lower water bodies. At least six, distinct large scale basal water bodies have been identified in Oahu. The basal water bodies are actually lenses of fresh water floating on denser salt water. Because the coastal margins of Oahu are overlain by substantial accumulations of alluvial and marine sediments (caprock), discharge of the

OAHU WATER CYCLE



The water cycle illustrates a typical island water system, such as for Oahu. Evaporation from the ocean off the windward coast forms clouds, at left. As the clouds rise over the mountains and cool, condensation occurs and rain pours on the uplands. Some of the water filters down through the watertight dike complex; much of the rest trickles through the mass of rock into the zone of fresh water underlying the island. Below this zone is salt water. A small amount goes into springs at *A*, and into surface streams. A blanket of caprock thickens the fresh-water zone. Some of this pure fresh water is drawn off by means of artesian wells drilled through the caprock at *B*. More is taken from well shafts and skimming tunnels at *C*. Small but important amounts of water are tapped from the dike complex at *D*. The water is brought to the surface, used and returned to the sea through ocean outfalls. Some of the rainwater runs over land surfaces into streams and returns also to the sea.

SOURCE: UNIVERSITY OF HAWAII, 1983

FIGURE 3.15

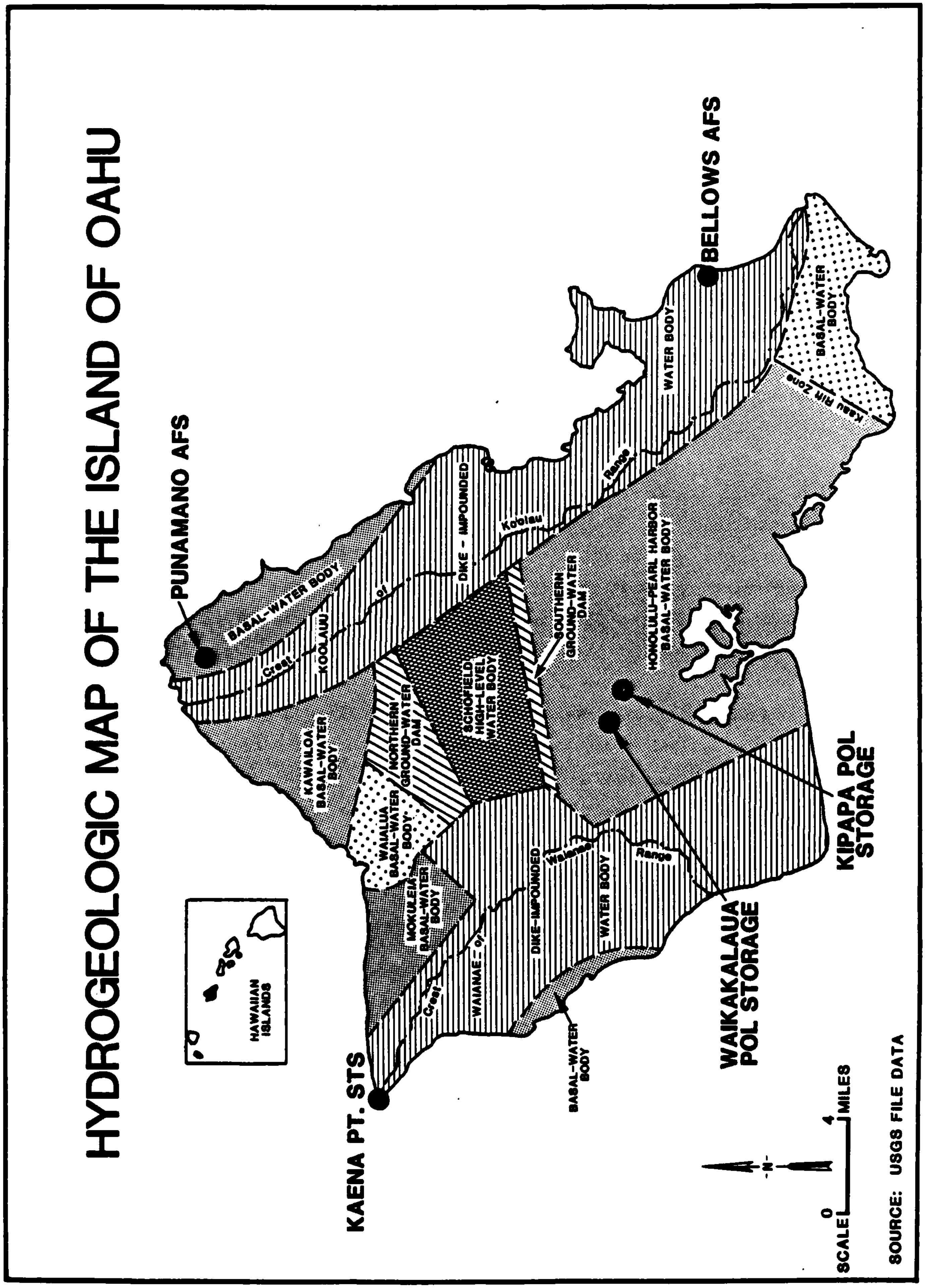
basal water bodies to the sea is somewhat restricted, creating artesian (confined) conditions in these areas. The high level and dike-impounded water bodies contain water under generally unconfined conditions. Figure 3.16 is a hydrogeologic map of Oahu. Figure 3.17 depicts generalized water elevation information for much of the study area.

Bellows AFS

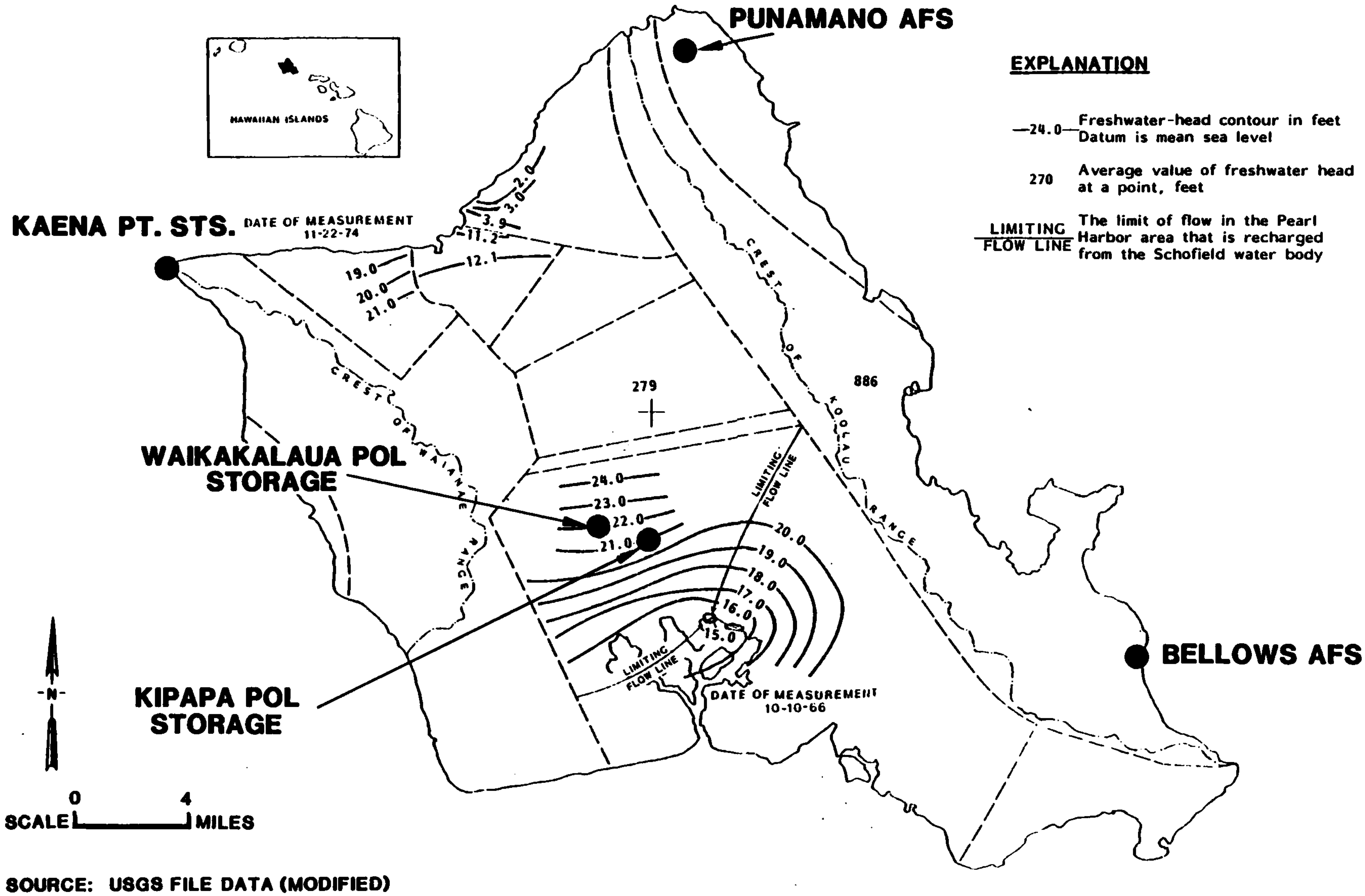
Bellows AFS is underlain by two major hydrogeologic zones, which are shown in Figure 3.18. The level lowlands are underlain by the Waimanalo Coastal Zone. This area is marked by wide coastal flats of alluvium and marine sediments overlying eroded volcanic materials. Along the beach areas, the alluvium is overlain by dune sand and modern beach deposits. The ground water is basal in this material (Takasaki and Mink, 1982). Some deep artesian water may be contained in sediments of the upper reaches. Most of the available shallow ground water is contained in the coralline layers. Takasaki (1977) reports that the deeper-occurring artesian water moves upward under the influence of confining pressures into the overlying permeable zones and finally to sea. Water contained in the shallow, near surface zones moves seaward without restriction. Figure 3.19 is a generalized hydrogeologic cross-section drawn through the Waimanalo area which illustrates the units present in the Bellows study area and their stratigraphic relationships. The slopes and upland areas of the station are underlain by the Waimanalo Inland hydrogeologic zone. This area consists of deeply eroded Koolau volcanic slopes overlain frequently by alluvium. Takasaki (1977) reports that the volcanics are probably intruded throughout. The principal occurrence of ground water in this area is dike-impounded water. Locally, shallow ground water may be contained in the alluvium (especially near streams) or in weathered lava zones as perched water. Most of the dike-impounded water moves toward the alluvium or into local stream channels. Figure 3.20 is the log of a fire protection well located at Bellows AFS. Water is derived from the sandy coral zones at a depth of 32 to 61 feet below ground surface.

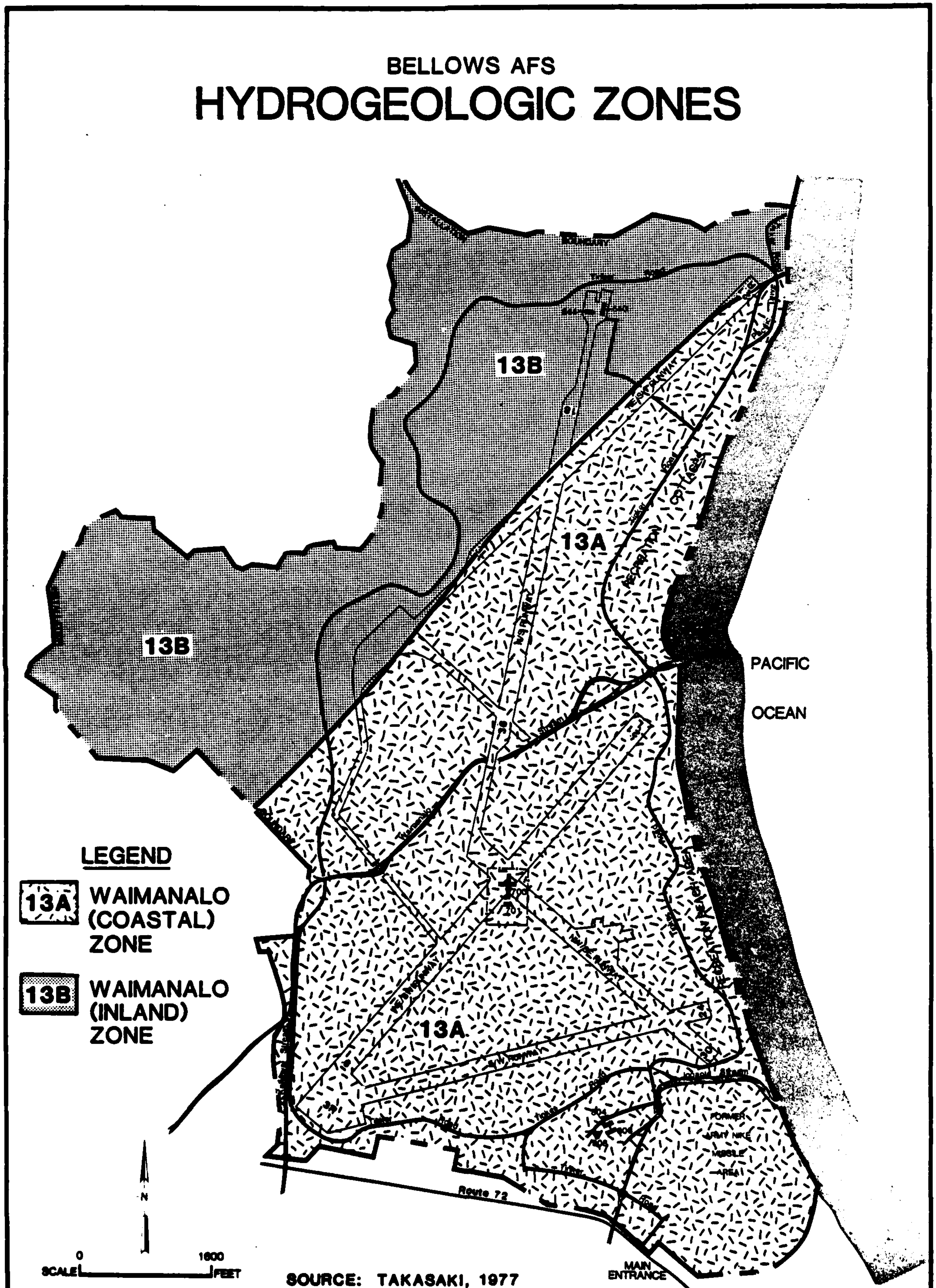
The water wells located on and around the station are maintained for fire protection use only and are not known to be utilized as a source of water supplies. A community water system furnishes local area supplies. Water contained in the shallow sediments near the station are

FIGURE 3.16


HYDROGEOLOGIC MAP OF THE ISLAND OF OAHU
PUNAMANO AFS
BELLOWS AFS
KAENA PT. STS
WAIKAKALAUA POL STORAGE
KIPAPA POL STORAGE
HAWAIIAN ISLANDS
BASAL-WATER BODY
Crest
of
KOOLAU
Koolau
Range
DIKE - IMPOUNDED
WATER BODY
BASAL-WATER BODY
Kaau Rift Zone
KAWAILOA BASAL-WATER BODY
NORTHERN GROUND-WATER DAM
SCHOFIELD HIGH-LEVEL WATER BODY
SOUTHERN GROUND-WATER DAM
HONOLULU-PEARL HARBOR BASAL-WATER BODY
WAIALUA BASAL-WATER BODY
MOKULEIA BASAL-WATER BODY
WAIANAE
Waianae
Range
DIKE-IMPOUNDED
WATER BODY
BASAL-WATER BODY
SCALE 0 4 MILES
N
SOURCE: USGS FILE DATA

FRESH WATER LEVEL MAP OF ISLAND OF OAHU





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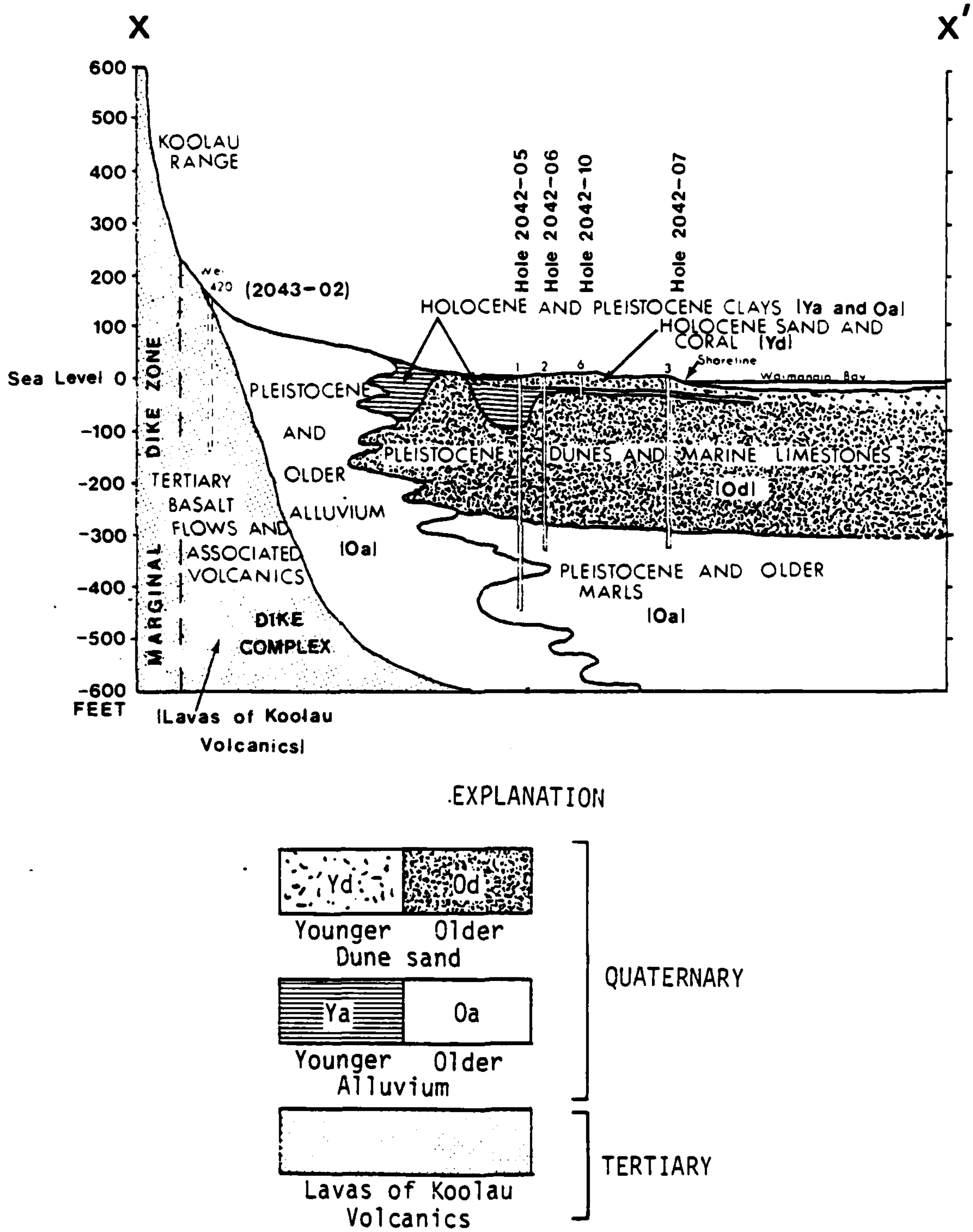
HYDROGEOLOGICAL SECTION OF COASTAL PLAIN IN WAIMANALO AREA

(Location of Cross-Section Shown on Figure 3.13)



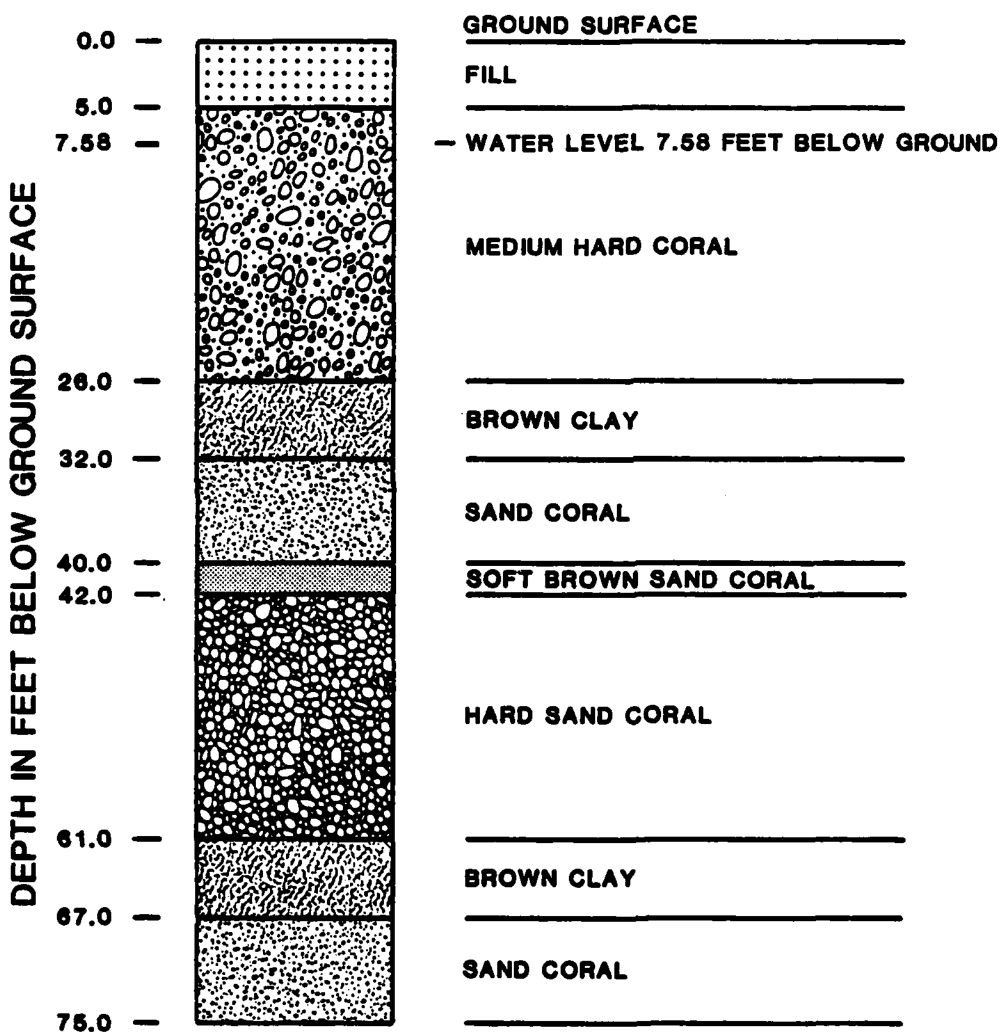
SOURCE: TAKASAKI AND MINK, 1982

SCALE 0 3000 FEET

BELLOWS AFS

FIRE PROTECTION WELL LOG

(USGS NO. 3-2243-01)



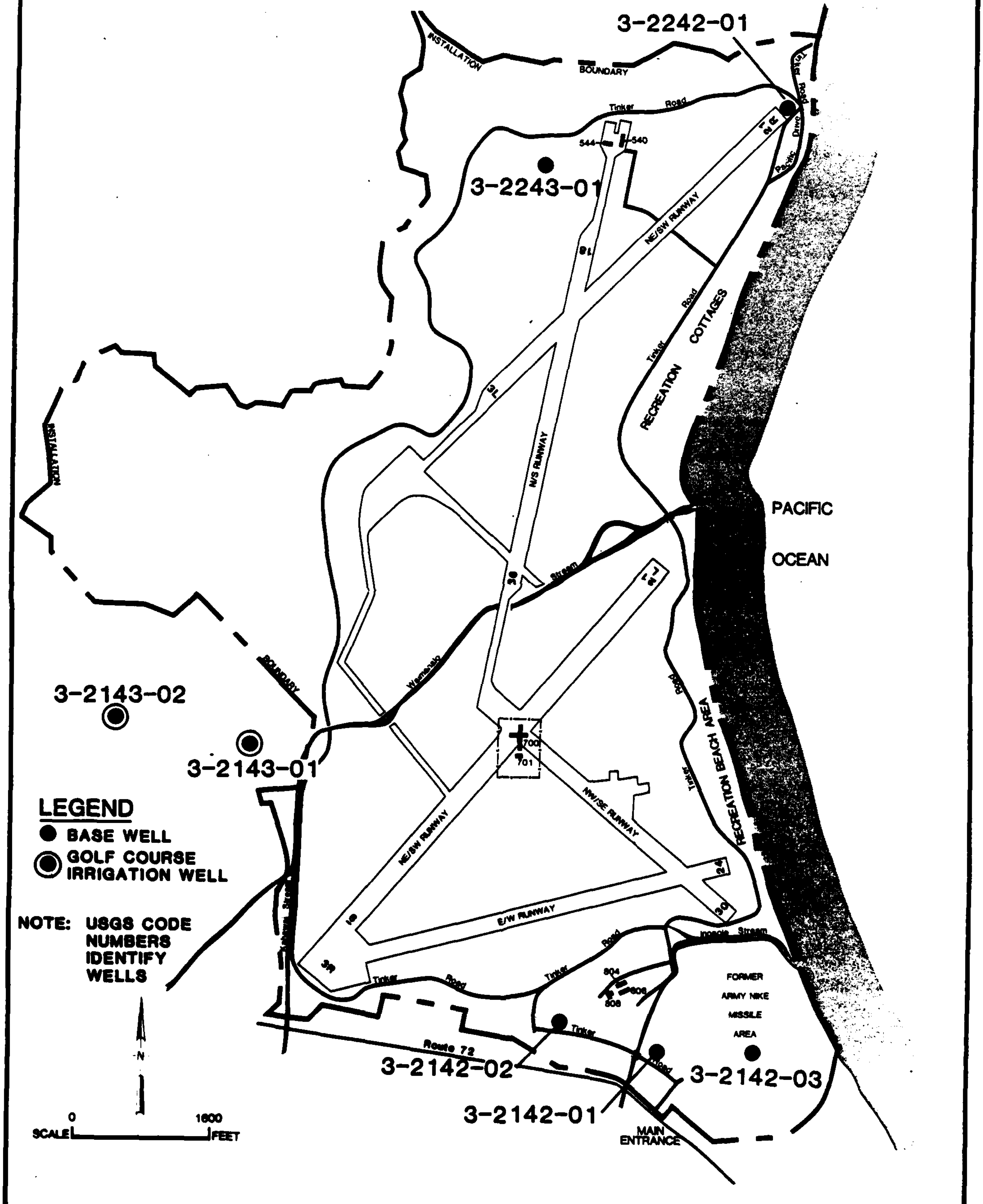
SOURCE: USGS FILE DATA

reported to be somewhat brackish and are therefore undesirable. South of the installation, the community sewage treatment plant injects treated water into deep zones beneath the study area. The locations of the five fire protection wells located on the installation are shown on Figure 3.21.

Kaena Pt. STS

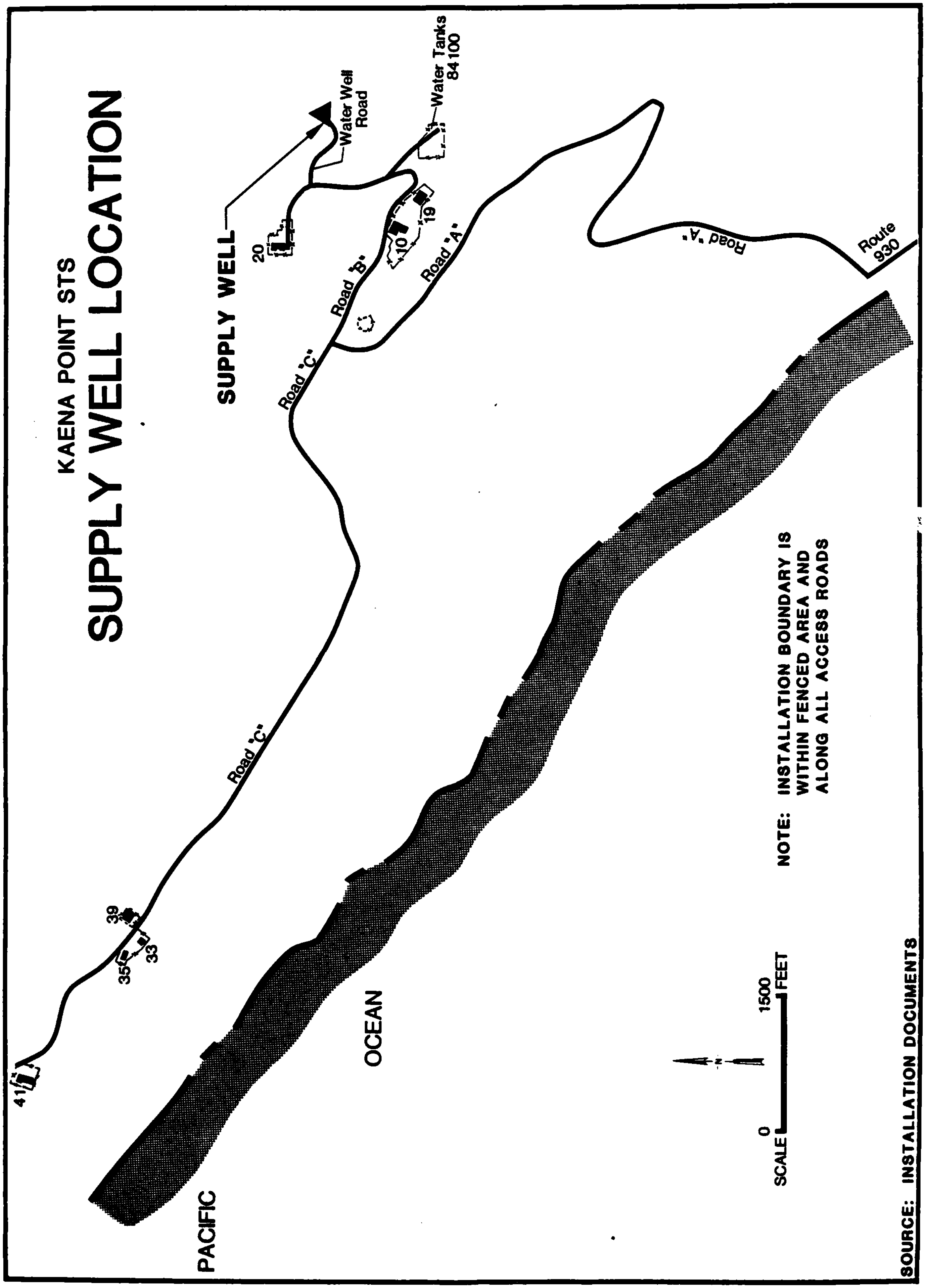
The Kaena Pt. STS straddles two hydrogeologic zones, the Mokuleia Inland Zone on the north side of the installation and the Waianae Range Leeward Slopes Zone on the south. The dividing line between the two roughly corresponds to the Waianae Range crest which extends along the west side of Oahu, nearly bisecting the landmass on which the installation is located. For the purposes of this discussion, however, there is little difference between the two hydrogeologic zones. Both consist essentially of deeply dissected Waianae slopes, in some places capped by massive members and to the north, thin-bedded highly dike-intruded lava flows. Ground water is dike-impounded in the upper reaches of the area or occurs as basal water dike-free lavas near the coastline. Small perched water bodies may be present locally. The direction of groundwater movement is generally seaward. No water resources are known to be developed in the immediate installation area. Most local water resources of the region have been obtained from basal waters in the Dillingham AFS area, or several miles south of the site at Ohiki-lolo. Formerly, the installation received its water supply through a pipeline from Dillingham AFS. Then a well was installed in a draw some 1000 feet east of the site, where the surface elevation is 1146.2 feet, MSL. The location of this well is shown in Figure 3.22. Figure 3.23 is the log of this well. The well log indicates that basal water exists in this area under generally unconfined conditions in the thinly bedded basalt flows that alternate with layers of clinker and scoria. The basal water elevation is indicated to be 13.7 feet, MSL, some 1132.5 feet below the local land surface. For several months the well has not been operational. Water supplies for the installation were trucked to the site from outside sources for a while and they are now provided through an old pipeline from Dillingham AFB. The well is expected to be operational again in the near future.

BELLOWS AFS
STUDY AREA WELL LOCATIONS



SOURCE: USGS FILE DATA

FIGURE 3.22



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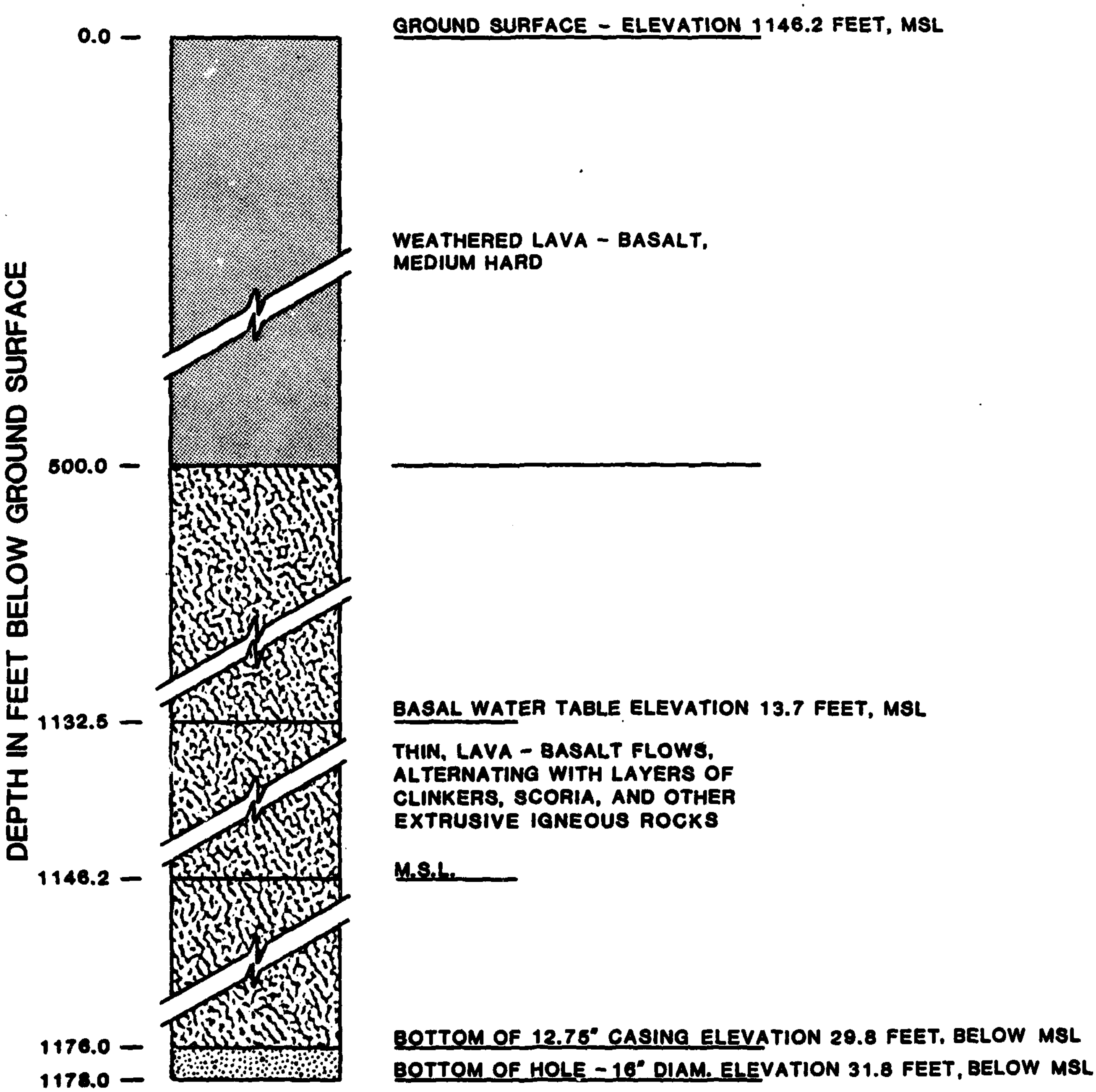
KAENA POINT STS

SUPPLY WELL LOG



NOTES:

(1) 2.0' OF OPEN HOLE, 16" DIAM. BELOW BOTTOM OF 12"

(2) NOTE ON INSTALLATION DRAWING INDICATES WELL MAY HAVE BEEN DEEPENED TO 62.5 FEET BELOW MSL SINCE ORIGINAL CONSTRUCTION

SOURCE: INSTALLATION DOCUMENTS

Punamano AFS

Punamano AFS is located within the Kahuku-Hauula (inland) hydrogeologic area (Takasaki, 1977). This station is situated on the moderately eroded, inclined Koolau lava slopes. Dike-impounded water occurs along crests and is basal in the dike-free areas. Water in this area could be an important source of future domestic and irrigation supplies. Ground water moves from the higher, dikes zone to the lower basal zone under water table conditions. Water of this general area is reported to be of good quality; the only perceived threat to local water quality is thought to be from individual septic systems. Moderate supplies of ground water are also available from the coastal deposits, located in the lowlands north of the station. The station's water supplies are obtained from a well located north of the site on the James Campbell Estate. The log of this well is presented as Figure 3.24. Supply wells immediately down-gradient of the station are noted on Figure 3.25. Wells constructed into the coastal deposits are usually on the order of 175 to 275 feet deep, and are screened at various depths into permeable strata. The depth to ground water immediately beneath the station may be on the order of 100 feet, based on the information presented in Figure 3.16. The elevation of ground water in the station's well located some 2400 feet north of the site is 12 feet, MSL, where the ground surface elevation is reported to be about 60 feet, MSL.

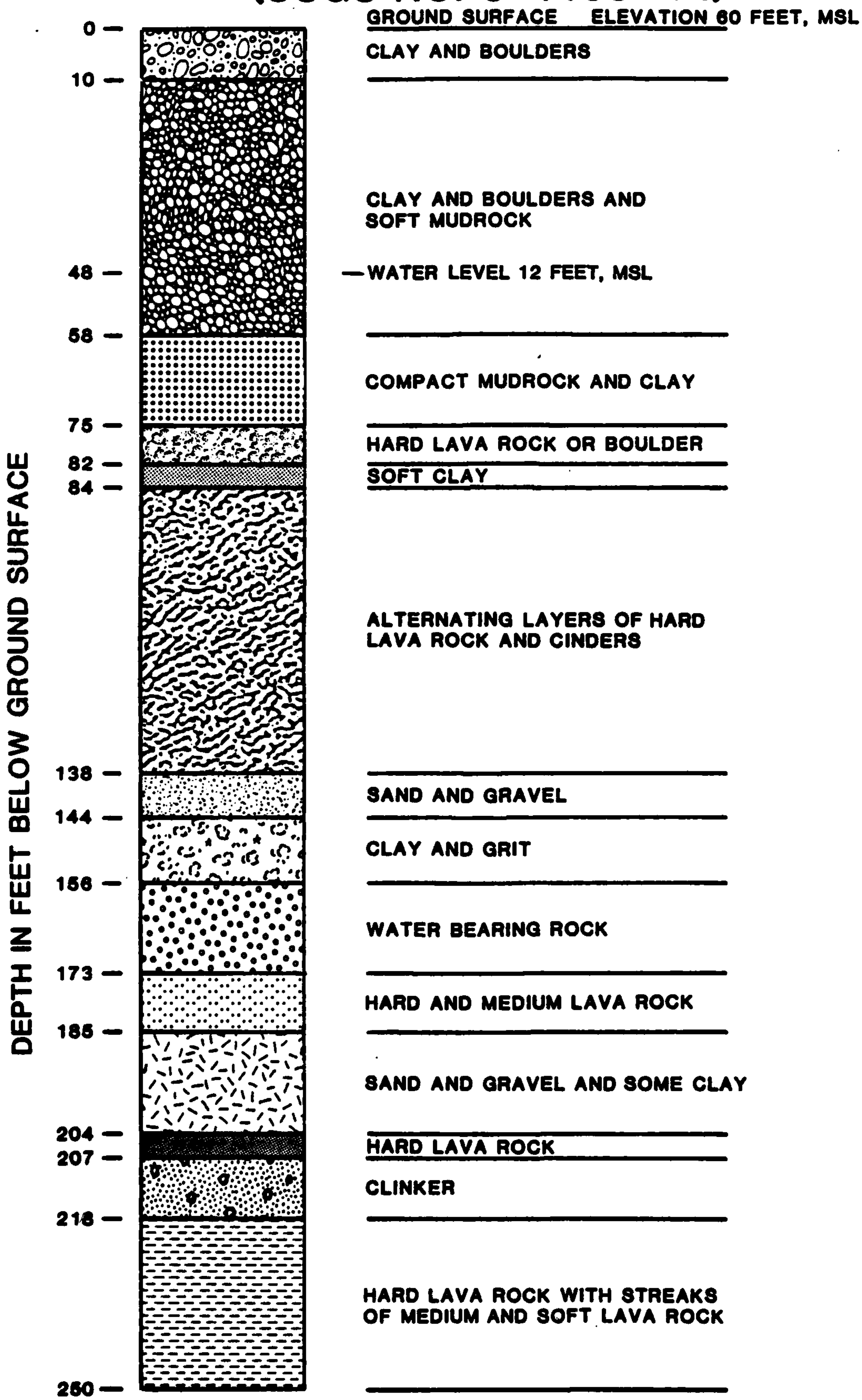
POL Storage Facilities

Both the Waikakalaua and Kipapa sites are located within the Inland Pearl Harbor Hydrogeologic Zone. The water-bearing unit of greatest importance here is the Pearl Harbor Aquifer, which is composed of thick sections of dike-free Koolau lavas. The ground water is identified as basal, that is it occurs as a massive unconfined lens floating on salt water. It is the most intensely developed source of water supplies on Oahu. Locally, ephemeral shallow aquifers may exist in the alluvium of active stream channels or in residual zones of the volcanic rock, such as that identified by Mink (1980), at Kunia. The perched aquifer at Kunia was reported to be a poorly permeable saprolitic material, existing from about 30 feet below ground surface, to a depth of 100 or more feet where unaltered rock may exist. Its total distribution is unknown, but similar aquifers could exist beneath or near the POL sites.

PUNAMANO AFS

SUPPLY WELL LOG

(USGS NO. 3-4158-12)

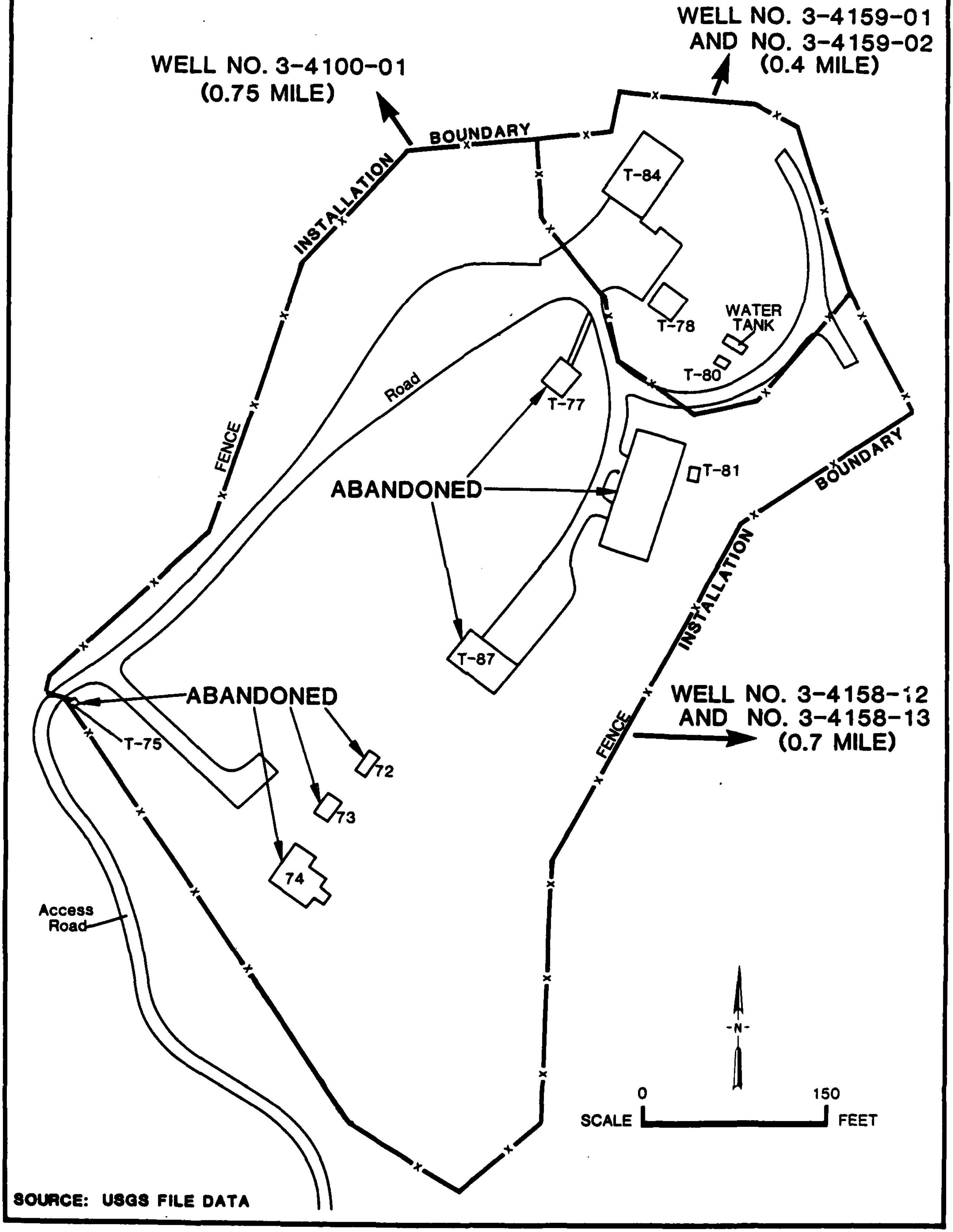


SOURCE: INSTALLATION DOCUMENTS

FIGURE 3.25

PUNAMANO AFS

STUDY AREA WELL LOCATIONS



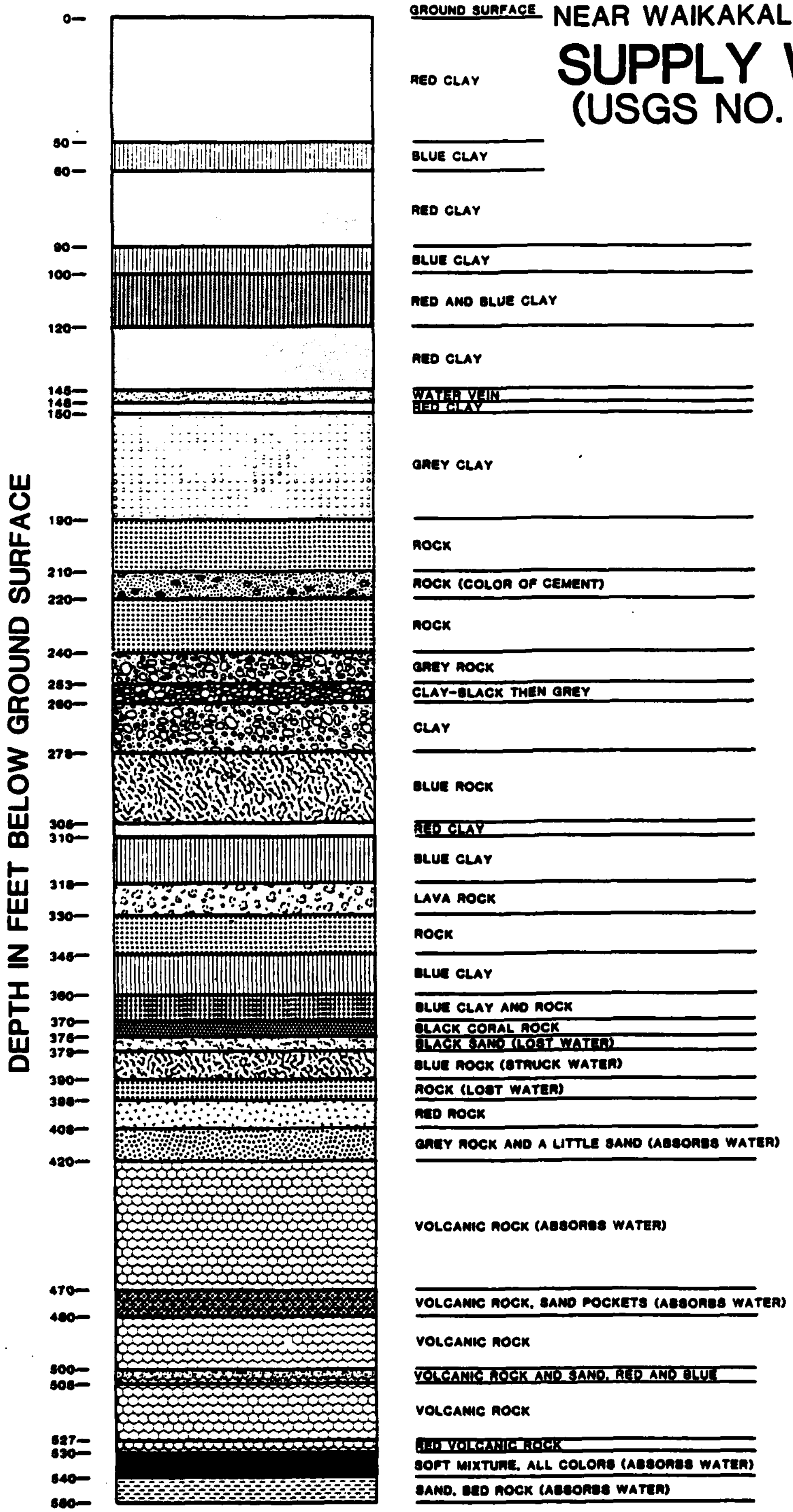
SOURCE: USGS FILE DATA

Ground water contained in the Pearl Harbor Aquifer occurs at great depth below the study area. It is estimated to be present at an elevation of 22 feet, MSL, or some 700 feet beneath land surface at Waikakalaua and approximately 400 feet below land surface at Kipapa. Figure 3.26 is the log of a well (no longer in use) drilled approximately 1800 feet east of the Waikakalaua site. This log depicts the presence of nearly 200 feet of poorly permeable clays in the upper section of the geologic column and waterbearing materials at depths of at least 318 feet below land surface. Figure 3.27 is the log of a well drilled 2000 feet south of the Kipapa facility in the valley of Kipapa Stream. This log indicates that more permeable materials are present in the stream valley lowlands than in the uplands where the Waikakalaua facility is situated. Wells located near the POL storage facilities are noted on Figures 3.28 and 3.29.

POL Pipeline

The northern extent of the pipeline is constructed across the land area of the Pearl Harbor Aquifer, which has been described above. The southern extent of the pipeline is located in the Pearl Harbor Coastal Hydrogeologic Zone. Figure 3.30 illustrates the hydrogeologic zones traversed by the pipeline. The Pearl Harbor Zone is a broad coastal plain of alluvial and marine sediments that reach a maximum thickness of some 1000 feet along the coast. These sediments are known collectively as the caprock, which overlies the Koolau basalts at greath depth. Ground water occurs in the permeable sand and coral zones at shallow depths under either water table or semi-confined conditions. The movement of water in these zones is usually directed toward local stream channels or to the harbor area. Water contained in the coral zones is extensively developed for irrigation purposes in the Ewa Plain. The principal source of potable water supplies in this area is the Pearl Harbor Aquifer, which contains water under artesian conditions due to its local confinement by the caprock. Water from the Pearl Harbor Aquifer tends to move upward under the influence of confining pressures to the surficial materials; locally, this has created springs and seeps. The artesian water surface rises to an average elevation of 15 feet, MSL in the Pearl Harbor area, where typical land surface elevations average 20 feet, MSL. The caprock materials may contain ground water at or near

NEAR WAIKAKALAUA POL STORAGE
SUPPLY WELL LOG
(USGS NO. 3-2701-01)



NOTE: WELL IS INACTIVE

SOURCE: USGS FILE DATA

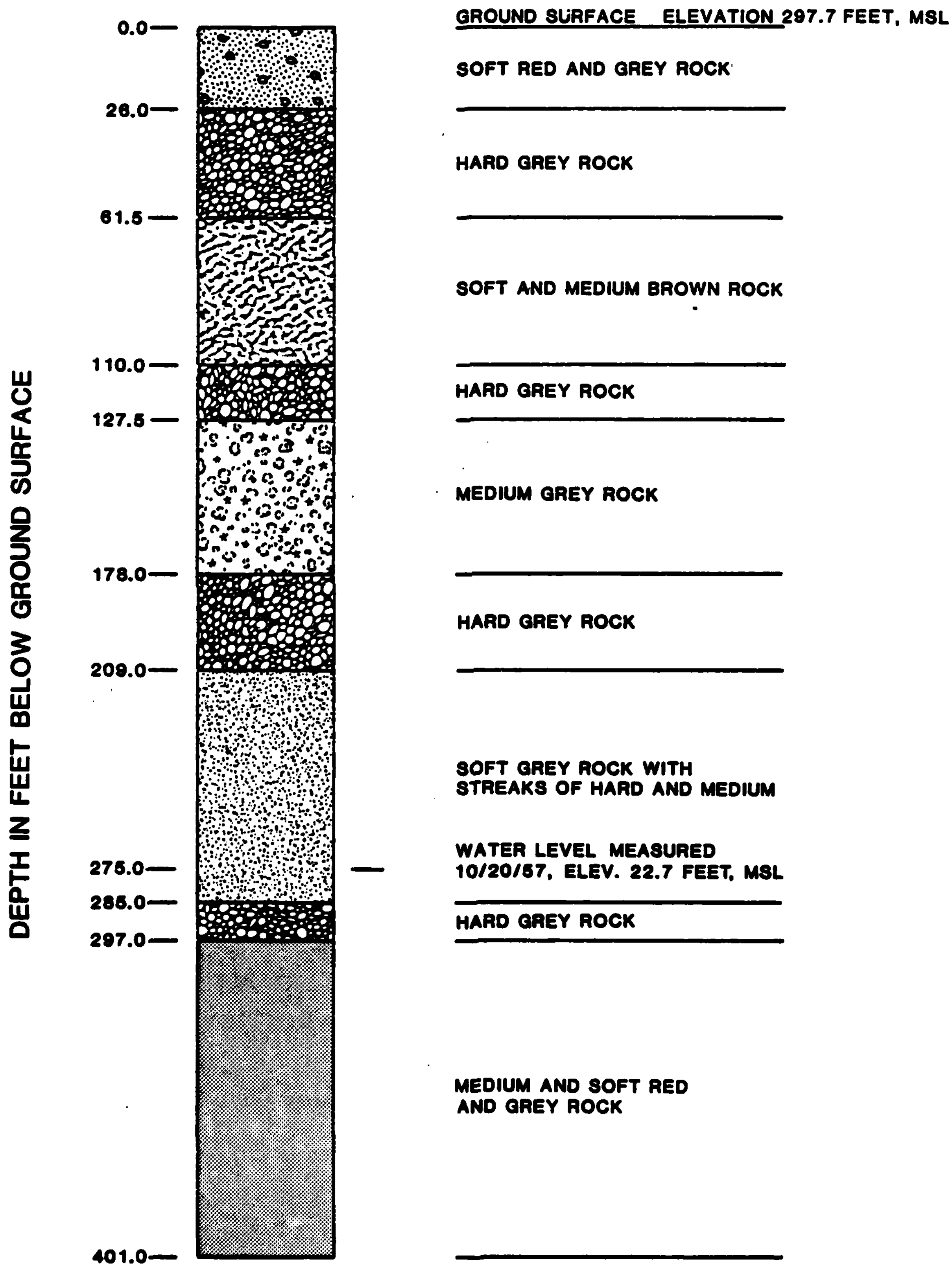
NOTE: WATER LEVEL NOT RECORDED

FIGURE 3.27

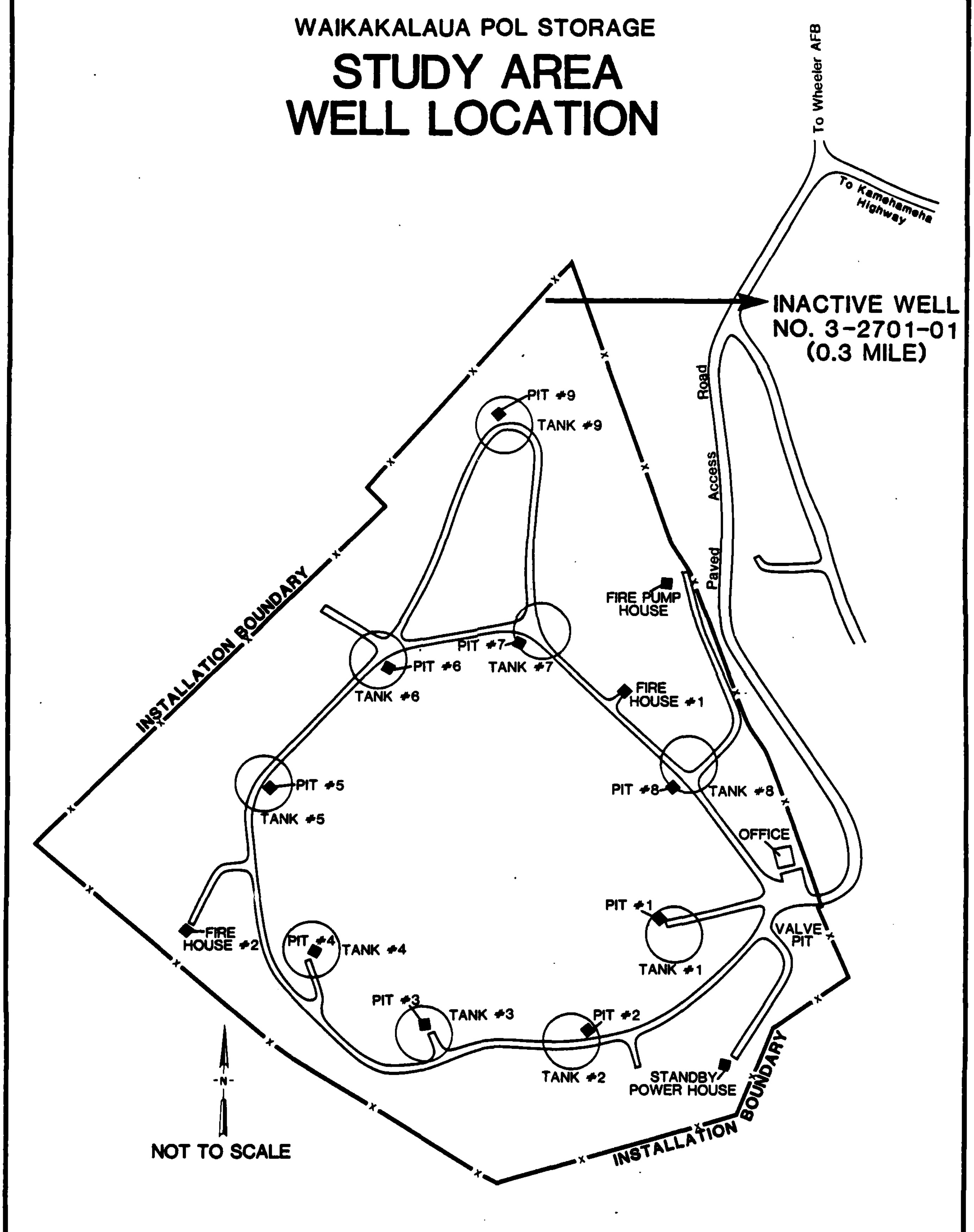
NEAR KIPAPA POL STORAGE

SUPPLY WELL LOG

(USGS NO. 3-2600-02)

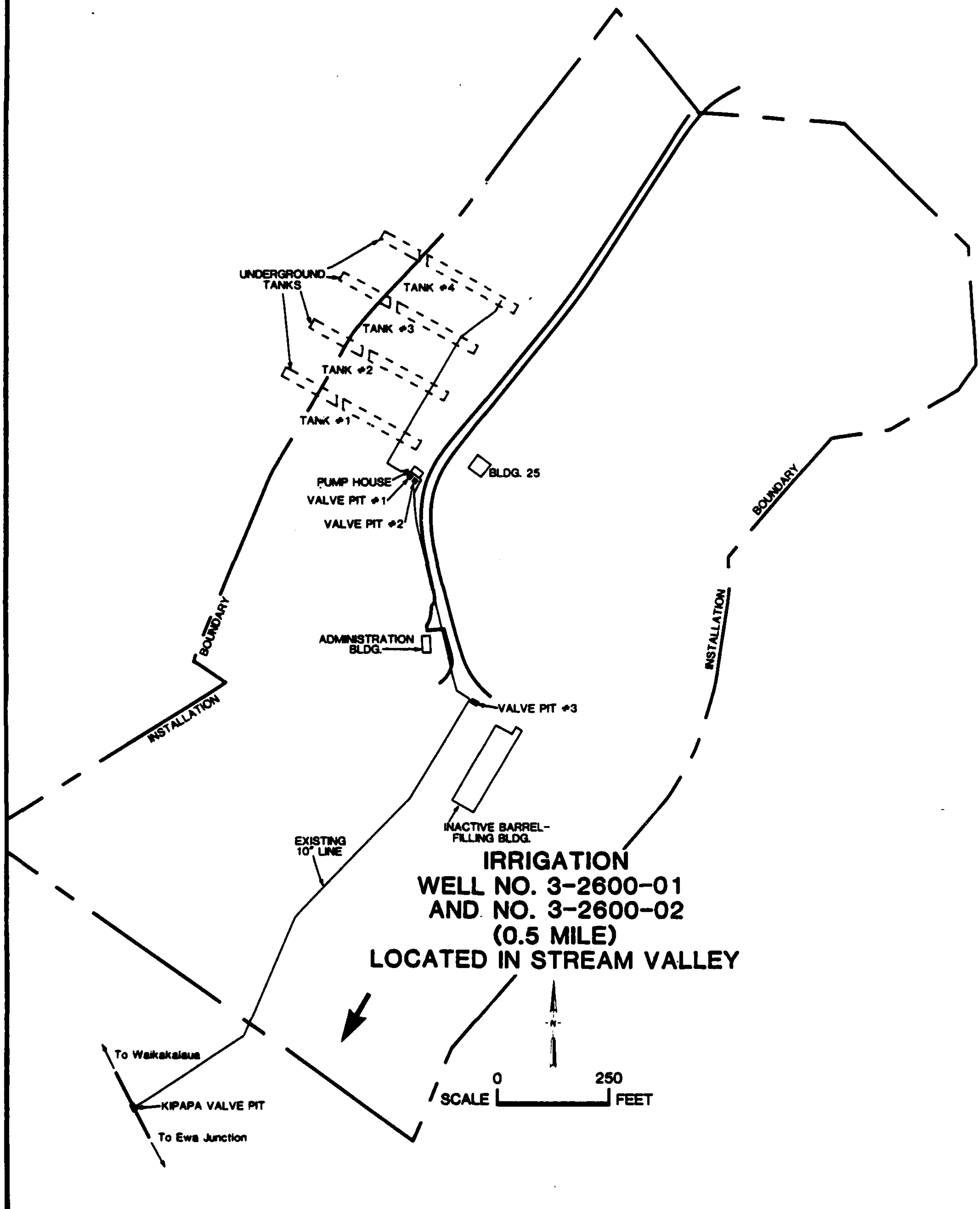


SOURCE: USGS FILE DATA

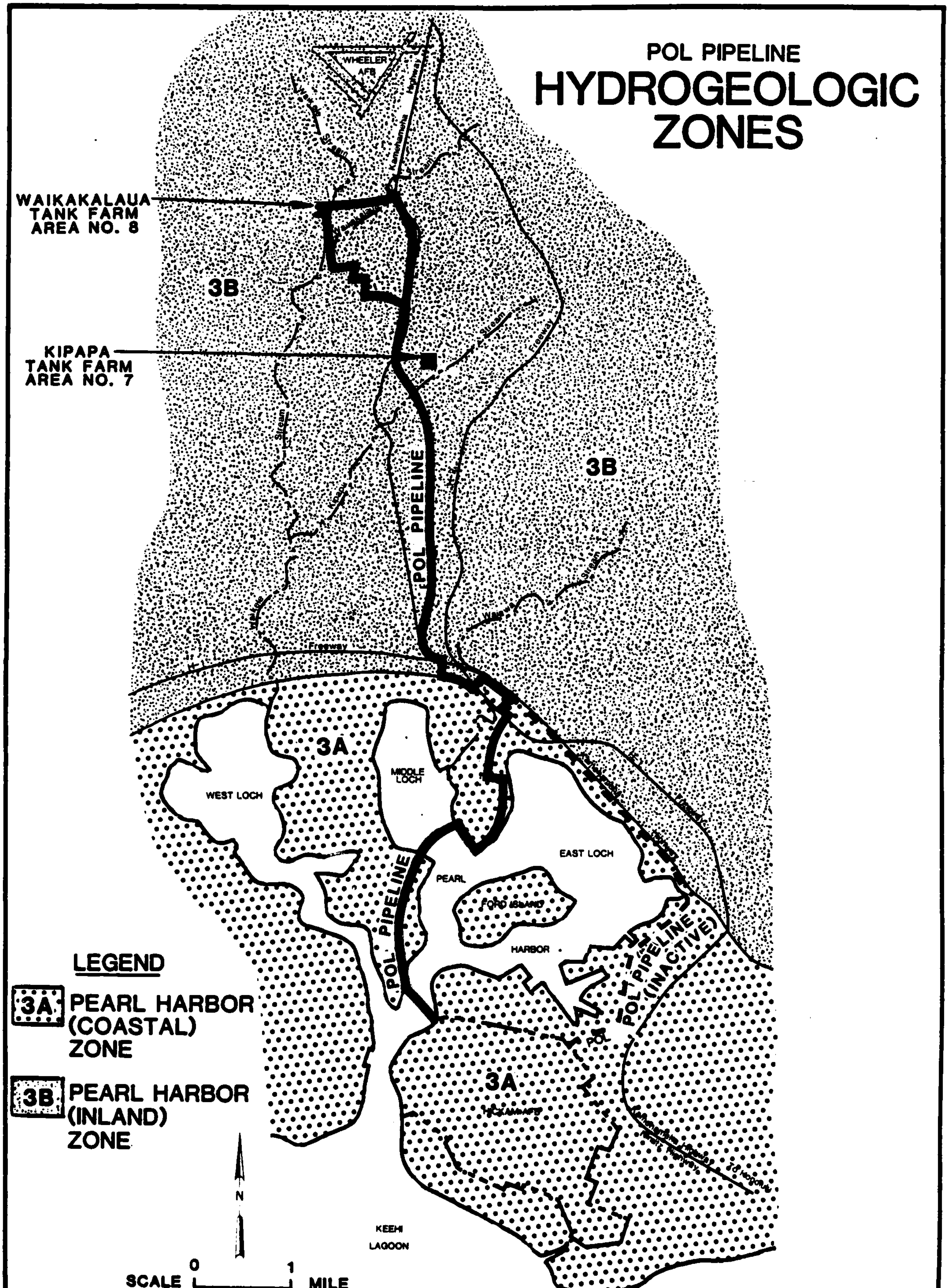


SOURCE: USGS FILE DATA

KIPAPA POL STORAGE
STUDY AREA WELL LOCATIONS



SOURCE: USGS FILE DATA



SOURCE: TAKASAKI, 1977

land suface in the immediate harbor area. Numerous water supply wells are located in the vicinity of the pipeline, most of which are high-capacity wells screened into the Pearl Harbor Aquifer. The locations of the principal municipal and other wells near the pipeline are shown on Figure 3.31. Only the high capacity wells are shown on Figure 3.31 and numerous other ones exist in the vicinity. Appendix D contains a listing of the wells graphically shown on Figure 3.31.

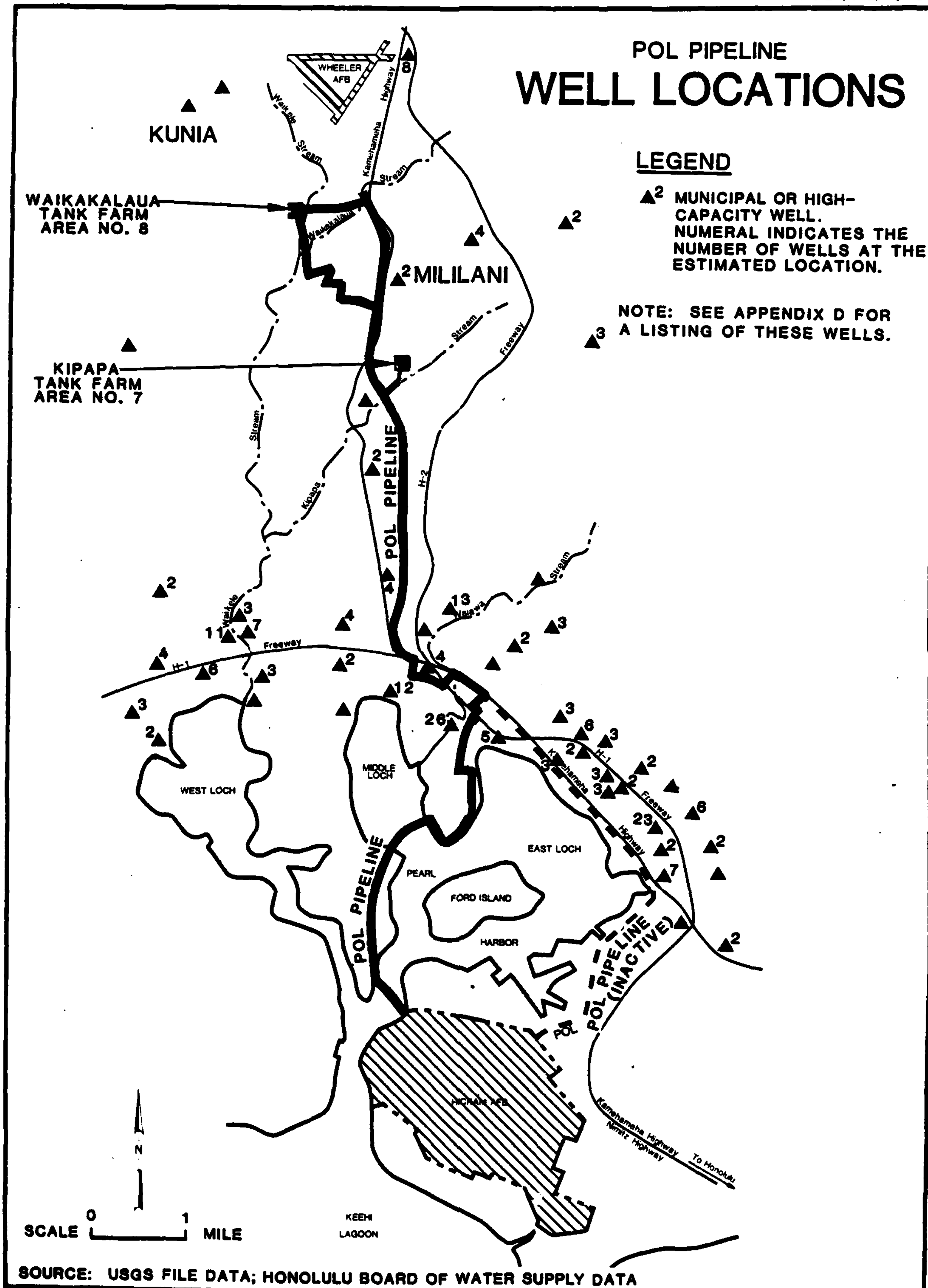
Kauai

Ground water occurs on the island of Kauai much as it does on Oahu, as perched, dike-impounded or basal water under either artesian or unconfined conditions. Shallow water table aquifers may be present locally, but these are usually restricted to coastal zone sediments those areas where substantial thicknesses of alluvium have accumulated as a result of stream channel development. Perched water aquifers are more common on Kauai than on Oahu, especially in the upland areas.

Kokee AFS

Kokee Air Force Station is located within the Napali Coast Hydrogeologic Zone. The permeable Napali Formation lava flows predominate in this area, cut by numerous dikes, locally. The upland areas are deeply dissected by many short stream valleys. High-level ground water is impounded by numerous dikes along the Napali Coast and provide flow to the many small springs common to the steep valley walls of the area (MacDonald, et al., 1960). Perched water may exist locally where downward flow is restricted by less permeable strata. Basal ground water exists in relatively limited areas near the coast due to the presence of the numerous dikes which cut across the Napali Formation. Sediment accumulations along the coastal margins, equivalent to Oahu's caprock restrict seaward flow somewhat. In the installation study area, ground-water flow is believed to consist principally of perched zone overflow to high-level zones (those impounded by dikes) to basal water bodies and finally to sea. The actual flow of ground water relative to the site is undocumented, but is believed to be generally down slope, following the local topography. The water levels within the Napali Formation beneath the installation are uncertain.

The installation derives its water supplies from a cistern which is designed to allow inflow into its large storage chamber from shallow



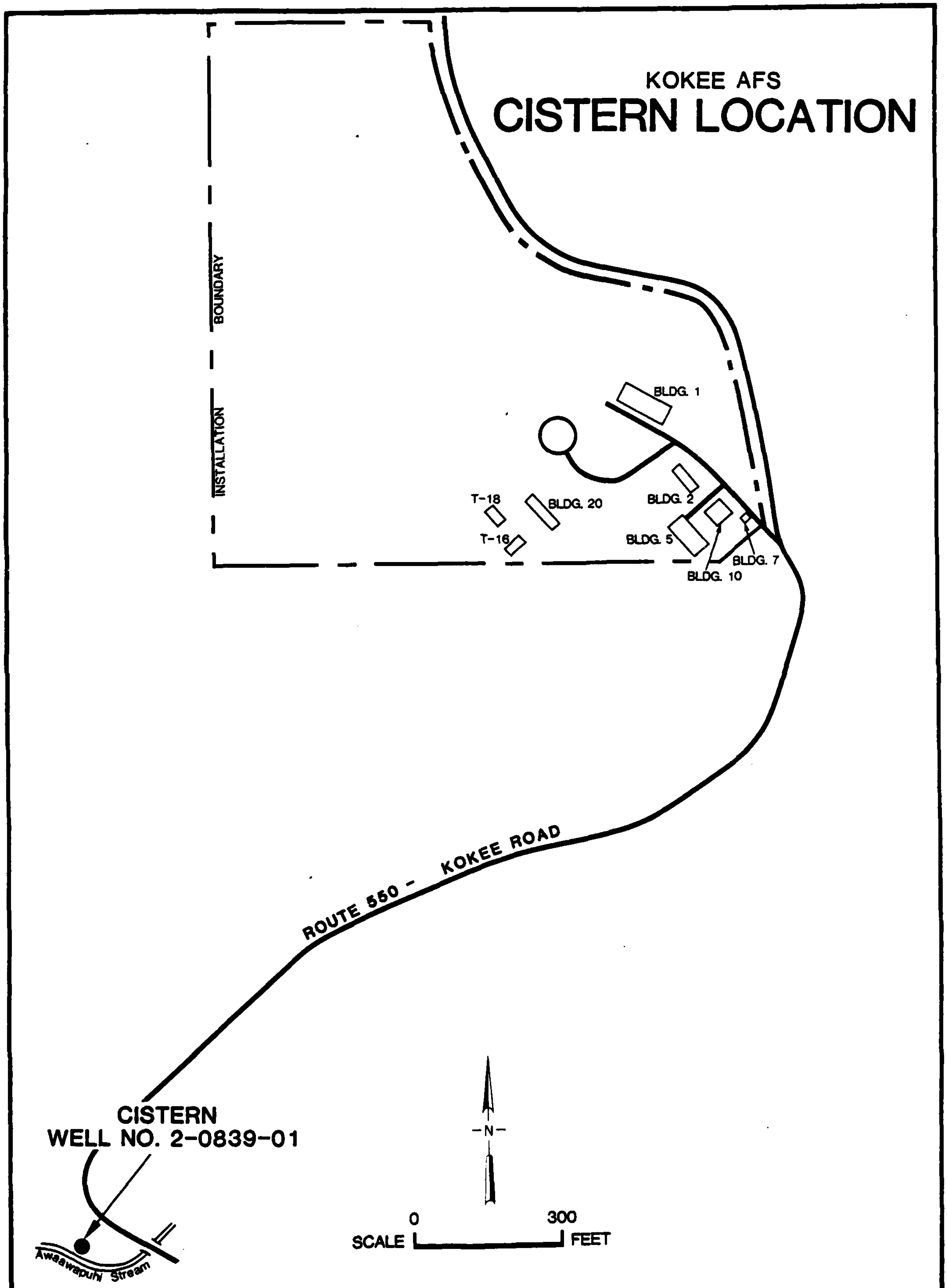
SOURCE: USGS FILE DATA; HONOLULU BOARD OF WATER SUPPLY DATA water-bearing materials adjacent to Awaawapuhi Stream. The cistern is reported to be 21.7 feet deep and is equipped with a 1.25 inch diameter discharge line and a three horsepower pump. The cistern is located near the station's access road where it crosses the stream and is identified in USGS files as well number 2-0839-01. In January, 1973, the water level in the discharge line was measured at 8.6 feet below the local land surface elevation, estimated to be 3960 feet, MSL. Because of the very permeable nature of stream alluvium and the Napali lavas typical of the area, this cistern-based water supply is easily susceptible to surface-related contamination impacts. Figure 3.32 illustrates the Kokee AFS study area and the location of the installation's water supply.

GROUND-WATER QUALITY

Information describing the quality of project area ground water has been obtained from Mink (1981); Garties (1984); and interview with a state official responsible for monitoring drinking water quality; an interview with a USGS chemist monitoring drinking water quality and from reviews of USGS file data.

The ground-water resources of both Kauai and Oahu have been described as generally good in quality with a few local exceptions. The most pronounced quality problem seems to be that of chloride levels in some coastal aquifers, which is associated with seawater intrusion or the connection between local ground waters and saline water bodies. This problem is most often managed by careful selection of aquifers from which to obtain water and the avoidance of over-drafting. In recent years, ground-water quality degredation has been observed in inland areas south of Wheeler Air Force Base by the chemicals dibromochloropropane (DBCP), ethylene dibromide (EDB) and 1,2,3-trichloropropane (Arizumi, 1984). Contaminant concentrations have been reported in both private and municipal wells in the parts-per-trillion range, except for the 1,2,3-trichloropropane which is present at levels of 1.5 to 2.2 ppb. The presence of these chemicals has been associated with the intensive agricultural use of the land north of Pearl Harbor, DBCP and EDB contamination has been reported at Kunia in both local soils and water by Mink (1981). The contamination of all five high capacity municipal

FIGURE 3.32



SOURCE: USGS FILE DATA AND INSTALLATION DOCUMENTS wells at Mililani by DBCP and EDB has been monitored for several years. One well was shut down in 1982 and two more wells were closed in 1983. At present, various treatment schemes are being evaluated to improve well water quality so that the wells may be restored to use with confidence (Garties, 1984).

Bellows AFS

Bellows AFS obtains its water supplies from local municipal sources. The quality of these purchased supplies is generally good. The five wells located at Bellows AFS are maintained for fire protection use only and contain water with varying amounts of chloride that preclude their use for potable supplies.

Kaena Pt. STS

Kaena Pt. STS currently obtains good water supplies from outside sources. The existing well was temporarily shutdown due to excessive drawdown and resulting poor quality water.

Punamano AFS

Punamano AFS obtains its water resources from a well located on the James Campbell Estate, north of the station on the coastal lowlands. Installation documents indicate that the quality of water obtained from this well is generally good.

Hickam POL Facilities

The Waikakalaua POL site obtains good quality water for drinking and fire protection from Wheeler AFB. The Kipapa POL site receives water for fire protection and sanitation from nearby agricultural wells; drinking water is hauled to the installation.

Kokee AFS

Kokee AFS obtains its water supplies form a cistern located just south of the installation. The quality of water collected from this source is reported to be acceptable. However, because of the unique susceptibility of this device to surface-related contamination, frequent testing should be performed to confirm the quality of water obtained from this system.

SURFACE WATER

The surface waters of the State of Hawaii have been classified in accordance with their present or potential utilization in order to maintain the highest quality standards possible. The classification system makes distinctions between inland and marine waters and further subdivides these broad categories. The detailed explanation of the classification system is presented in Title 11, Chapter 54, Water Quality Standards (State of Hawaii, 1981). The classification of water uses for surface waters extending through or proximate to the 15th ABW Satellite Facilities are listed in Table 3.5.

Surface water quality monitoring is performed by the Air Force on a rountine basis in surface waters extending through Bellows AFS and waters proximate to the Hickam POL Facilities in order to comply with USAF regulations and State of Hawaii laws, Title 11, Chapter 55, Water Pollution Control (State of Hawaii, 1982a). A review of water quality monitoring data for both installations indicates that the quality of local surface waters is generally good. Published historical information also indicates that the quality of water adjacent to these facilities has been generally acceptable (Engineering-Science, et al., 1972). The locations of surface water sampling points at Bellows AFS are shown on Figure 3.33.

Several large-scale losses of fuel have occurred in past years from the fuel pipeline. Surface waters near or downslope of the leakage point may have received some POL products.

ENDANGERED AND THREATENED SPECIES

Several endangered and threatened species are endemic to the general study area which includes the islands of Kauai and Oahu (State of Hawaii, 1982a; U.S. Department of the Interior, Fish and Wildlife Service, 1983). Because the islands are small, numerous breeding sites may exist in the limited land area of each island. Therefore, an entire island may be considered as the distribution area where an individual plant or animal could be present at any time. Two endangered birds are known to inhabit marshy lowlands of Bellows AFS. They are the Hawaiian Gallinule and the Stilt.

According to available data, seventeen birds, three reptiles, one mammal, one mollusk and three plants are considered to be either endangered or threatened in the general project area. Appendix D (from Hawaii Division of Forestry and Wildlife, 1983) lists the endangered and threatened species of Hawaii and their known ranges of distribution.

TABLE 3.5

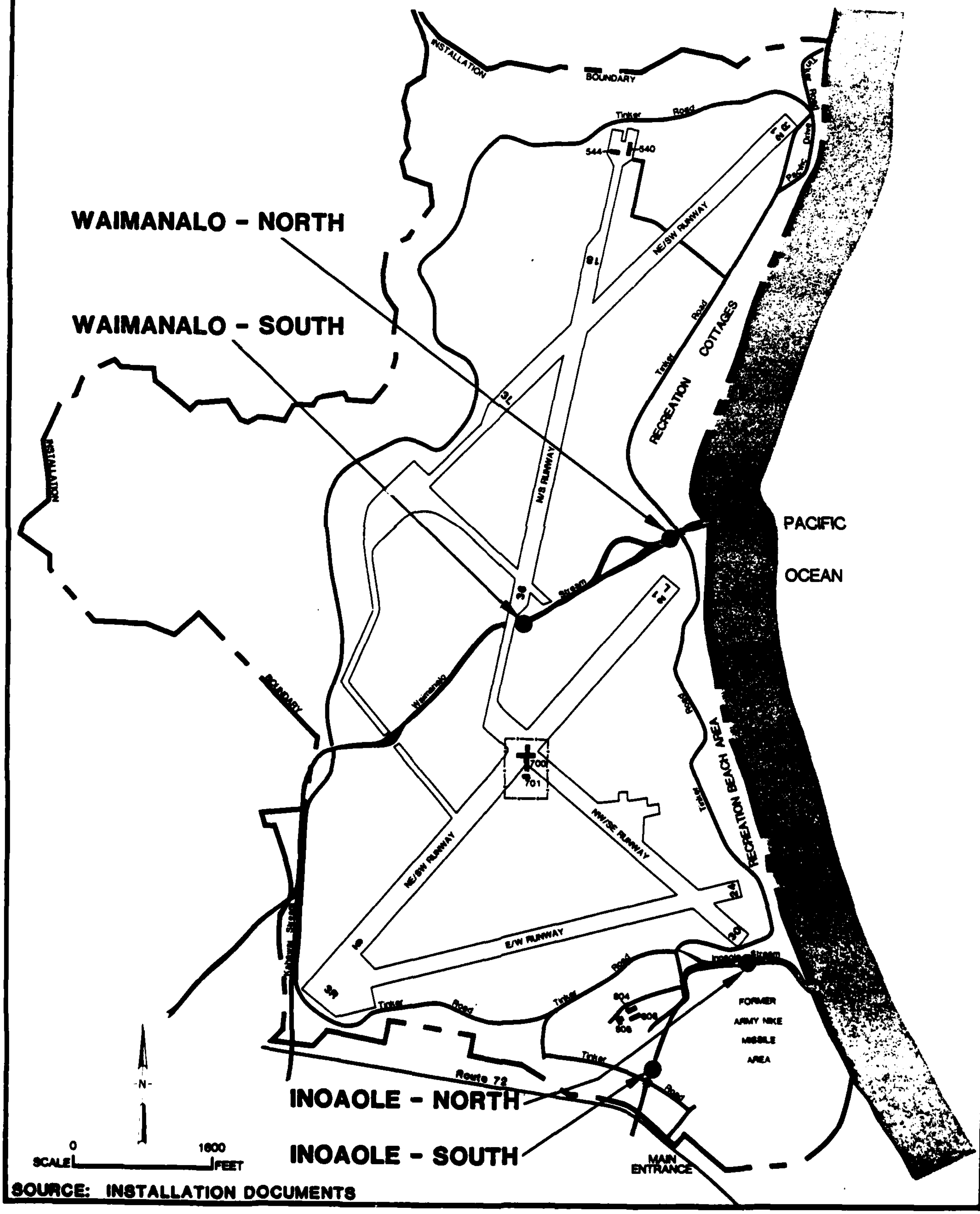
SUMMARY OF SURFACE WATER CLASSIFICATIONS

Facility	Water Body	Type	Classification [1]
Bellows AFS	Waimanalo Stream (P)	Inland	2
	Inoaole Stream	Inland	2
	Waimanalo Bay (P)	Marine	A
Kaena Pt. STS	Beach Areas (P)	Marine	AA
Punamano AFS	Unnamed Stream North of Site (P)	Inland	1.a
POL Storage Facilities	Waikele Stream	Inland	2
	Kipapa Stream	Inland	2
POL Pipeline	Waikakalaua Stream	Inland	2
	Kipapa Stream	Inland	2
	Waikele Stream	Inland	2
	Waiwa Stream	Inland	2
	Pearl Harbor (P)	Marine	2
Kokee AFS	Awaawapuhi Stream (P)	Inland	1.a

Notes: (1) Explanation of Classification System is presented in State of Hawaii (1982b).

(P) Denotes a perennial water body. All others are intermittent, except in lower reaches in coastal areas.

BELLOWS AFS
SURFACE WATER SAMPLING LOCATIONS



SOURCE: INSTALLATION DOCUMENTS

SUMMARY OF ENVIRONMENTAL SETTING

The environmental setting data reviewed for this investigation indicate that several significant items are relevant to the evaluation of past hazardous waste disposal and fuel handling practices at the 15th ABW Satellite Installations. A generalized discussion is presented below. Information pertinent to each individual site is presented in Table 3.6.

- Precipitation distribution across the islands is highly variable. The greatest amounts of rainfall are measured on the windward side and in the uplands of the islands. The amount of annual precipitation available for infiltration at a given site ranges from 6 to 59 percent.
- The surface soils at all of the sites are described as being moderately permeable.
- Shallow aquifers probably communicating with local surface waters are present at or near land surface at the following sites: Bellows AFS, POL Pipeline (coastal area) and Kokee AFS. Shallow ground water may be present locally in dike-impounded areas at Punamano AFS. All of these installations are situated in the recharge zones of their respective shallow aquifers.
- The Hickam POL Storage Facilities and the northern extent of the fuel pipeline are located in the recharge area of the primary deep aquifer supplying water resources to nearly all of Oahu. Although the water level is present at great depth below land surface (700 feet at Waikakalaua and 400 feet at Kipapa), the unsaturated zone is considered to be quite permeable and, therefore, vulnerable to surface related contamination. Contamination of this aquifer due to agricultural activity near the POL facilities has been documented.
- The surface waters entering and exiting Bellows AFS and the POL facilities are considered to be of good quality.
- Two endangered birds inhabit the marshy lowlands of Bellows AFS. Although no threatened or endangered species is known to inhabit any of the other sites, they may transit any of the areas at any time.

TABLE 3.6

SUMMARY OF ENVIRONMENTAL CONCERNS

	Potential Receiving Environments				
Facility	Soil	Surface Water	Shallow Aquifer	Regional Aquifer	Threatened or Endangered Species
Bellows AFS	Yes	Yes	Yes	No	Yes
Kaena Pt. STS	Yes	No	No	No	Yes
Punamano AFS	Yes	Yes	Yes	No	Yes
POL Storage Facilities	Yes	Yes	No	Yes	Yes
POL Pipeline (North - Upland Area)	Yes	Yes	No	Yes	Yes
POL Pipeline (South - Coastal Area)	Yes	Yes	Yes	No	Yes
Kokee AFS	Yes	Yes	Yes	No	Yes

Source: Engineering-Science, 1984.

From these major points it may be seen that pathways for the migration of hazardous waste-related contamination or POL loss exist at all of the sites. Contamination could be directed to local surface waters, shallow or deep aquifers, continuing to migrate beyond installation boundaries and have adverse effects on public health or the environment.

SECTION 4
FINDINGS

This section summarizes the hazardous wastes generated by installation activities, identifies hazardous waste accumulation and disposal sites located on the installations, and evaluates the potential environmental contamination from hazardous waste disposal sites. Past waste generation and disposal methods were reviewed to assess hazardous waste management practices at the 15th ABW Satellite Installations.

INSTALLATION HAZARDOUS WASTE ACTIVITY REVIEW

A review was made of past and present installation activities that resulted in generation, accumulation and disposal of hazardous waste. Information was obtained from files and records, interviews with past and present installation employees and site inspections.

The sources of hazardous waste at the installations studied are grouped into any or all of the following categories:

- Industrial Operations (Shops)
- Waste Accumulation Areas
- Fuels Management
- Spills and Leaks
- Pesticide Utilization
- Fire Protection Training

The subsequent discussion addresses only those wastes generated at the satellite installations which are either hazardous or potentially hazardous. Potentially hazardous wastes are grouped with and referenced as "hazardous wastes" throughout this report. A hazardous waste, for this report, is defined by, but not limited to, the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). For study purposes, waste petroleum products such as contaminated fuels, waste oils and waste solvents are also included in the "hazardous waste" category.

No distinction is made in this report between "hazardous subtances/ materials" and "hazardous wastes". A potentially hazardous waste is one which is suspected of being hazardous although insufficient data are available to fully characterize the material.

Industrial Operations (Shops)

Summaries of industrial operations were developed from installation files and interviews. Information obtained was used to determine which operations handle hazardous materials and which ones generate hazardous wastes. Summary information on all installation shops is provided as Appendix E, Master List of Shops.

For the shops identified as generating hazardous wastes, personnel were interviewed to determine the types and quantities of materials and present and past disposal methods. Information from 15th ABW files and interviews with installation employees is summarized in Table 4.1, which is located at the end of this discussion. The waste quantities presented in this table are based either on available file data or estimates of present quantities by installation personnel. Past disposal practices, presented as a timeline, are based on information obtained from former and current installation employees.

Bellows AFS

Industrial wastes from Bellows AFS currently are from three areas: 1957th Communications Group, NAF motor pool and the Hawaii Army National Guard (HARNG).

Since it started operations in 1956, wastes from the 1957th Communications Group have been stored in an underground storage tank and routinely hauled to off-base disposal. Motor pool wastes and HARNG wastes have been hauled off-base to other military installations for many years.

Information concerning industrial waste operations in the 1940's and earlier is somewhat limited due to minimal file data and unavailability of several long-term employees at Bellows AFS. One long-term former employee confirms that there were industrial shop operations active on a small-scale basis during the World War II period from 1943 until about 1946 when Bellows was placed in caretaker status. A 1943 drawing from Hickam AFB files shows engine, welding, machine, heat treatment, aero repair, battery, paint, reclamation, and armament shops in a relatively confined area at Bellows AFS near the current CE shop area. Some wastes in drums from these operations were taken to the installation landfill and disposed in a pit at the site. It appears probable that the septic tank system also received some hazardous materials.

Kaena Pt. STS

Kaena industrial wastes are predominately lubricating and hydraulic fluids from the antennae, petroleum products from the diesel power plant and cleaning fluids. Wastes are transported off-base. A small amount of water used for rinsing miscellaneous parts at the power plant (Building 39) drains along a paved area and then onto the ground.

Punamano AFS

Lubricating oils from the diesel generators are the only current industrial wastes at Punamano AFS and these are hauled to off-base disposal. In the period from approximately 1962 to 1965 a motor pool (garage) generated small quantities of oil from minor vehicles repair operations done at the installation. These were disposed of on the site.

Hickam POL Facilities

Both the Waikakalaua and Kipapa POL storage areas have generated sludges from tank bottoms. The tanks have been cleaned on a 8 to 10 year interval and disposal of the residuals has been at each specific installation.

Kokee AFS

Lubricating and hydraulic oils from antennae, petroleum products from the motor pool and generator plant, cleaning fluid and paint thinners are the wastes from industrial operations at Kokee AFS. Until about 1977, some waste oils were routinely spread along the AFS perimeter fence for weed control. All other wastes were hauled off-base. Small quantities of used paint thinners have been periodically disposed of at the installation.

TABLE 4.1
INDUSTRIAL OPERATIONS (Shops)
Waste Management

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	CURRENT WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL 1940 1950 1960 1970 1980
BELLOWS AFS				
1957 COMMUNICATIONS GROUP, OL-A	700, 701, 703	LUBRICATING OILS, SOLVENTS, ANTIFREEZE, PAINT THINNERS, CLEANING COMPOUNDS	150 GALS./YR.	1956 OFF-BASE CONTRACTOR
NAF MOTOR POOL	540	LUBRICATING OILS, PD-680	55 GALS./YR.	1940 TO HICKAM AFB 1974
291st MAINTENANCE CO. (HARNG)	804, 806, 808	LUBRICATING OILS, CLEANING SOLVENTS	330 GALS./YR.	TO FT. RUGER 1970
MISCELLANEOUS WWII SHOPS	---	OILS, SOLVENTS, PAINT THINNERS, ACIDS	330 GALS./YR.	LANDFILL 1943 1946
KAENA PT. STS				
ANTENNA AND COMMUNICATIONS OPERATIONS	10, 13, 19	LUBRICATING AND HYDRAULIC OILS, KEROSENE, FREON, ALCOHOL, TRICHLOROTRI-FLUOROETHANE	110 GALS./YR.	1959 OFF-BASE TO OIL RECLAMATION
ANTENNA, MAINTENANCE AND GENERATOR PLANT	39, 35, 41	LUBRICATING AND HYDRAULIC OILS, DIESEL FUEL, CLEANING SOLVENTS	935 GALS./YR.	TO SCHOFIELD BARRACKS; OFF-BASE DISPOSAL 1959 1979
GENERATOR PLANT	39	OILY RINSEWATER	1000 GALS./YR.	DISPOSED ON GROUND 1965
PUNAMANO AFS				
GENERATOR PLANT	T-78	LUBRICATING OILS	55 GALS./YR.	TO SCHOFIELD BARRACKS; OFF-BASE DISPOSAL 1979
MOTOR POOL (HANG)	T-87	LUBRICATING OILS	4 GALS /YR.	DISPOSED ON GROUND 1962 1965

KEY
——— CONFIRMED TIME-FRAME DATA BY SHOP PERSONNEL
- - - - - - ESTIMATED TIME-FRAME DATA BY SHOP PERSONNEL

NOTE: QUANTITIES SHOWN ARE CURRENT; PAST QUANTITIES MAY MAY HAVE BEEN HIGHER OR LOWER.

TABLE 4.1 (cont'd)

INDUSTRIAL OPERATIONS (Shops)

Waste Management

SHOP NAME	PRESENT LOCATION (BLDG. NO.)	WASTE MATERIAL	CURRENT WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL (1940–1980)
WAIKAKALAUA POL				
POL TANKS	---	RESIDUAL TANK CLEANING SLUDGES	5500 GALS. EVERY 8-10 YRS.	SLUDGE PITS 1943–1975
KIPAPA POL				
POL TANKS	---	RESIDUAL TANK CLEANING SLUDGES	8500 GALS. EVERY 8-10 YRS.	SLUDGE PITS –1976
KOKEE AFS				
ANTENNA, MOTOR POOL AND GENERATOR PLANT	1,2,10	LUBRICATING AND HYDRAULIC OILS, CLEANING SOLVENTS	110 GALS./YR.	DISPOSED ON GROUND AND OFF-SITE 1961–1977; TO BARKING SANDS PMRF 1977–
SUPPLY/MAINTENANCE	5	PAINT THINNERS	5 GALS./YR.	DISPOSED ON GROUND 1961–

KEY

——— CONFIRMED TIME-FRAME DATA BY SHOP PERSONNEL

- - - - - - ESTIMATED TIME-FRAME DATA BY SHOP PERSONNEL

NOTE: QUANTITIES SHOWN ARE CURRENT; PAST QUANTITIES MAY HAVE BEEN HIGHER OR LOWER.

Waste Accumulation Areas

Punamano AFS and Hickam POL Facilities

Punamano and the Hickam POL installations do not accumulate hazardous materials prior to off-base disposal.

Bellows AFS

As shown in Figure 4.1 and in photographs in Appendix F, there are three locations where waste oils and other liquid wastes (solvents, thinners, etc.) are accumulated at Bellows AFS prior to collection and disposal off the installation.

The NAF motor pool stores waste petroleum products and cleaning solvents in drums adjacent to Building 540 prior to transport to Hickam AFB. The 1957th Communications Group utilizes a 300 gallon below ground storage tank to contain oil and other liquid wastes from its operations. A contractor pumps this tank out about once every two years and disposes the contents off the installation. The HARNG stores waste lubricating oils and cleaning solvents in drums near Building 808 prior to collection and transport to Ft. Ruger.

Kaena Pt. STS

Waste oils and other liquid wastes at Kaena Pt. are stored in drums near the waste sources and then moved to an accumulation area at the diesel power plant (Building 39). The drums are hauled to off-base disposal locations. Figure 4.2 and a photograph in Appendix F show the location of the main waste accumulation area at Kaena Pt.

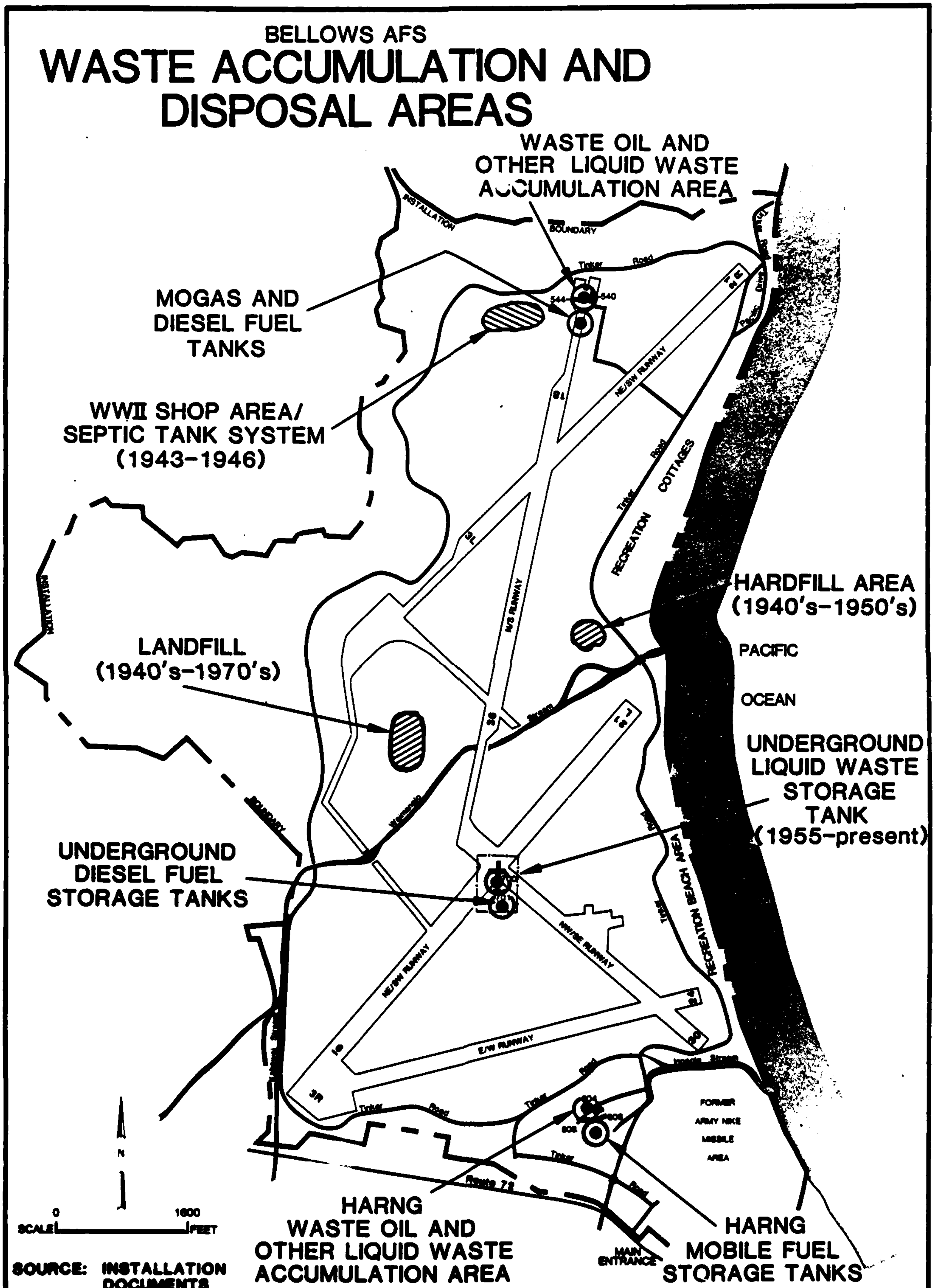
Kokee AFS

At Kokee AFS waste oils and cleaning solvents are stored in drums adjacent to Building T-6 (Figure 4.3 and Appendix F). These drums are transported to an off-base disposal location.

Fuels Management

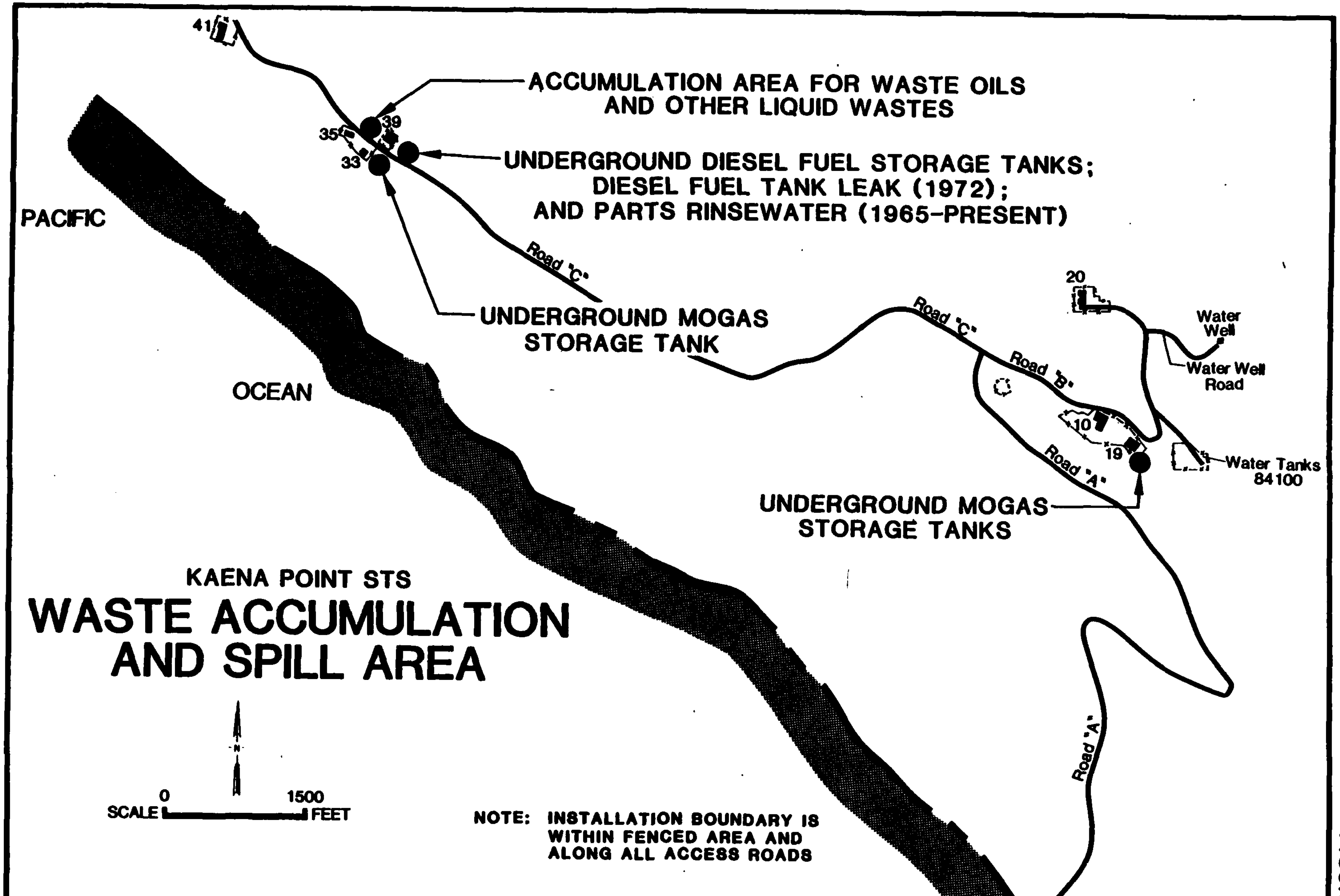
The liquid fuels systems for the 15th ABW Satellite Installations consist of both above and below ground storage tanks. Fuels stored include MOGAS, diesel fuel, and JP-4. Appendix D lists the fuel tanks at the various installations. Appendix F shows photographs of several fuel storage facilities. Following is a discussion of the fuels systems at each 15th ABW Satellite Installation. Spills and leaks from these facilities are discussed in a subsequent section.

FIGURE 4.1



BELLOWS AFS
WASTE ACCUMULATION AND DISPOSAL AREAS
WASTE OIL AND OTHER LIQUID WASTE ACCUMULATION AREA
MOGAS AND DIESEL FUEL TANKS
WWII SHOP AREA/ SEPTIC TANK SYSTEM (1943-1946)
HARDFILL AREA (1940's-1950's)
LANDFILL (1940's-1970's)
PACIFIC OCEAN
UNDERGROUND LIQUID WASTE STORAGE TANK (1955-present)
UNDERGROUND DIESEL FUEL STORAGE TANKS
INSTALLATION BOUNDARY
Tinker Road
NE/SW RUNWAY
N/S RUNWAY
NW/SE RUNWAY
E/W RUNWAY
RECREATION COTTAGES
RECREATION BEACH AREA
FORMER ARMY NIKE MISSILE AREA
Route 72
MAIN ENTRANCE
N
SCALE 0 1600 FEET
HARNG WASTE OIL AND OTHER LIQUID WASTE ACCUMULATION AREA
HARNG MOBILE FUEL STORAGE TANKS
SOURCE: INSTALLATION DOCUMENTS

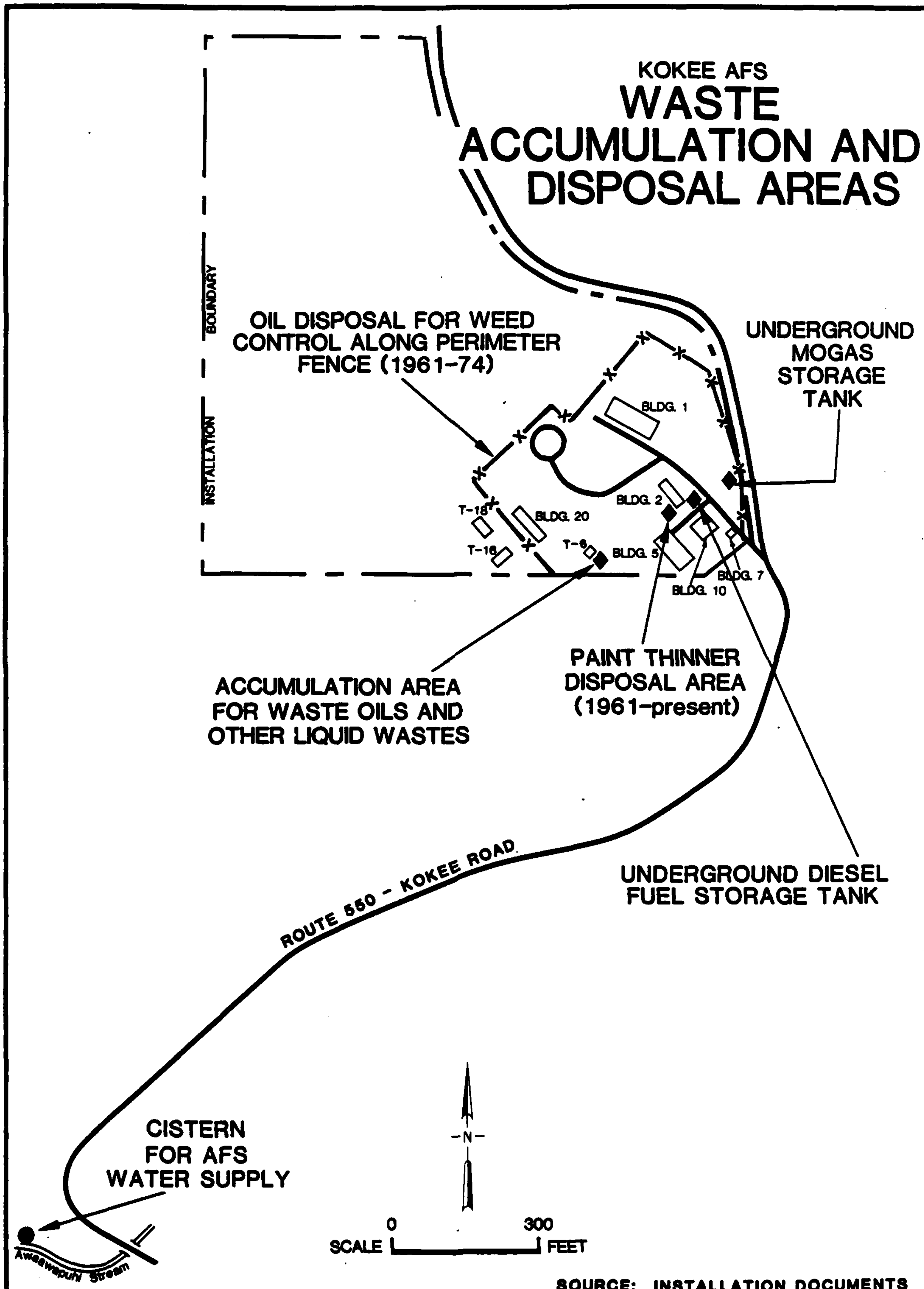
FIGURE 4.2



KAENA POINT STS
WASTE ACCUMULATION AND SPILL AREA

NOTE: INSTALLATION BOUNDARY IS WITHIN FENCED AREA AND ALONG ALL ACCESS ROADS

SOURCE: INSTALLATION DOCUMENTS



SOURCE: INSTALLATION DOCUMENTS

Bellows AFS

Fuels at Bellows AFS are currently stored at three locations (Figure 4.1). MOGAS and diesel fuels are stored in tanks near the CE/ motor pool area (Buildings 540 and 544). Diesel fuel for the 1957th Communications Group is stored in tanks adjacent to Building 701. The HARNG also has two portable MOGAS or diesel fuel tanks normally located near Building 808.

The fuel tanks at Bellows AFS have not been cleaned, inspected or tested for leaks. Inventory records are used to assess leakage.

Kaena Pt. STS

Kaena Pt. STS has underground tanks which supply diesel fuel to the generator plant and MOGAS tanks for installation vehicles (Figure 4.2). These tanks have not been cleaned or inspected/tested, but inventory controls are used for assessing leakage.

Punamano AFS

Diesel fuel storage tanks are provided at Punamano adjacent to Building T-78 for the generator equipment. Inventory control is used for assessing leakage. The tanks have not been cleaned.

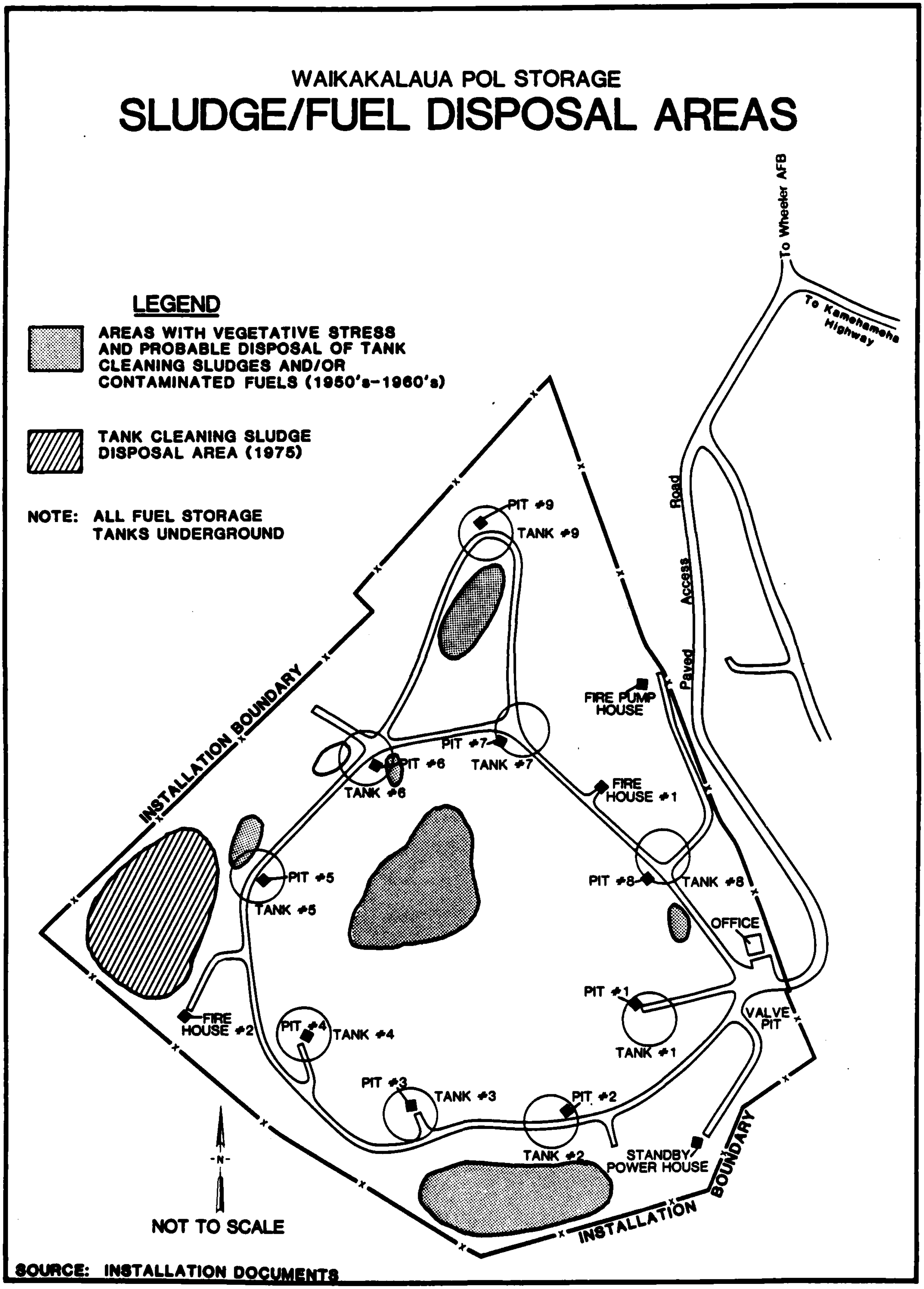
Waikakalaua POL

All nine underground fuel tanks located at this Hickam POL Facility are currently used for storing JP-4. These facilities were used to store AVGAS until about 1963 when they were gradually converted to JP-4. By 1971 all tanks were converted to JP-4. There reportedly was a period of two to three years (late 1960's) when a few tanks stored MOGAS.

The Waikakalaua storage tanks are constructed of steel which is totally encased in concrete. Annual interior inspections of tank conditions are performed. Each tank is periodically taken out of service for several days and the contents are monitored to assess any leaks. Pressure testing is performed on the Waikakalaua POL facility piping to determine leaks.

The storage tanks have been cleaned every eight to ten years. The last cleaning of all tanks took place in 1975. The residual tank sludges were placed in a shallow, bermed pit near the western corner of the site (Figure 4.4) for weathering and subsequent burial. The total quantity of tank sludge removed in 1975 is estimated to be approximately 5,500 gallons. Sludges from all previous tank cleaning operations have

FIGURE 4.4



ES ENGINEERING-SCIENCE

been disposed of on the Waikakalaua POL facility. The quantities of sludge removed and disposal location are not specifically known. However, several areas on the site with vegetative stress (see Figure 4.4 and photographs in Appendix F) may be sludge burial pits.

The tank cleaning immediately preceding the one in 1975 took place in 1966. Based upon the reported cleaning frequency, sludge has probably been removed from the tanks on four separate occasions since the original construction in 1943. The sludge materials during the period when all AVGAS and MOGAS were stored (1942-71) would have contained lead and other fuel additives such as EDB. The JP-4 residuals would not have included these chemicals.

Some of the areas with no vegetation at Waikakalaua are also reportedly due to disposal of small amounts of contaminated fuels from valve pits and other appurtenances.

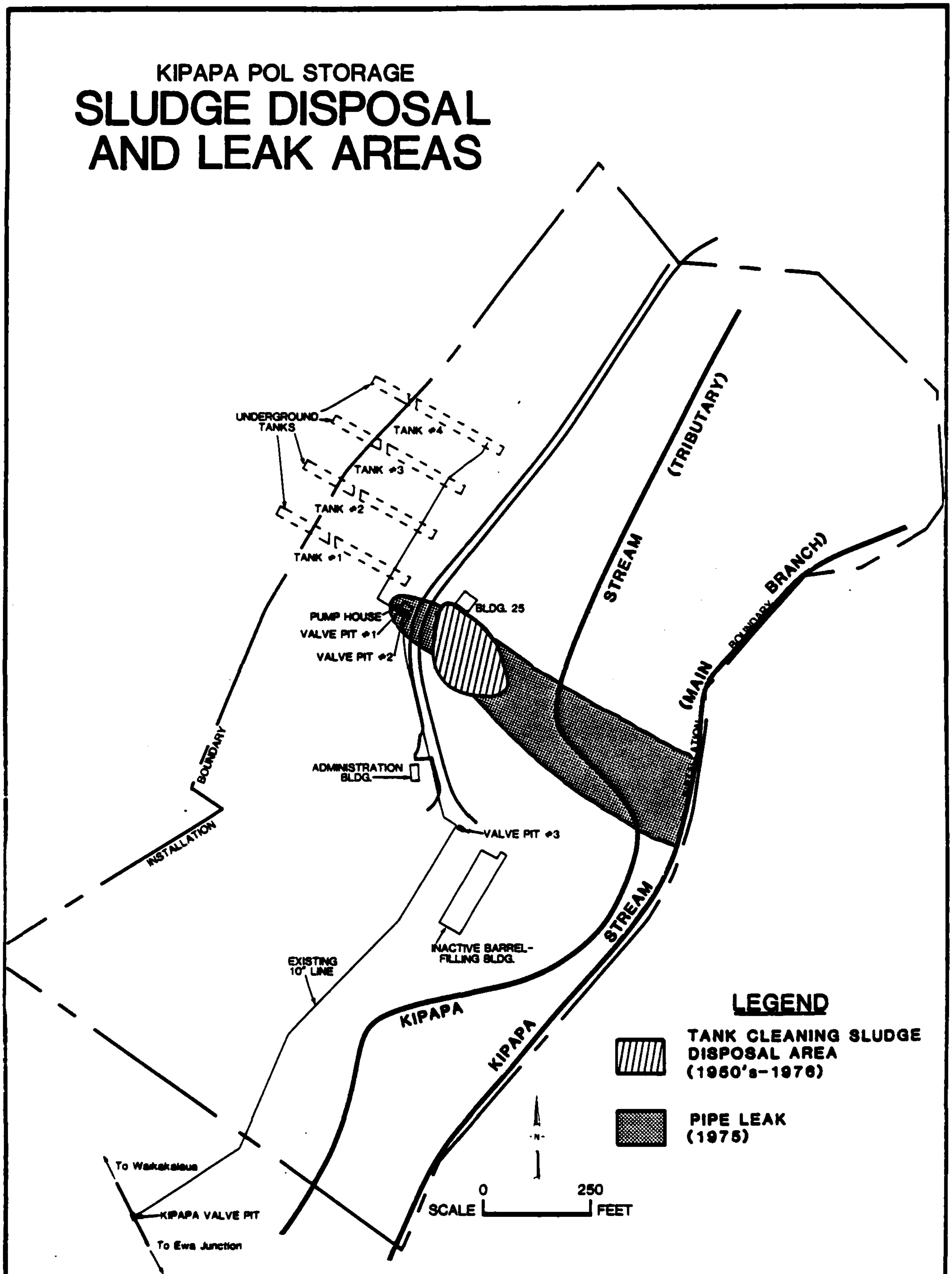
Kipapa POL

JP-4 is currently stored in the four Kipapa POL tanks. These tanks were gradually converted from AVGAS to JP-4 in the same period as the Waikakalaua facility (1963-71).

The Kipapa fuel storage reservoirs consist of tunnels horizontally bored into Kipapa Gulch. Each tunnel or tank has a reinforced concrete encased steel liner with concrete ends. Annual tank interior inspections are made of the steel liner. Potential leaks are monitored through routine inventory control and daily gauge readings.

Kipapa fuel tanks were last cleaned in 1976. The sludge material removed from each tank was placed in a shallow bermed pit near Tank No. 1 as shown in Figure 4.5. After weathering the material was buried. The quantity of sludge buried in 1976 was approximately 8,500 gallons.

As with the Waikakalaua installation, the cleaning which preceded the 1976 one was in 1966. The frequency of cleaning for Kipapa is also about the same, eight to ten year intervals. Information concerning tank cleanings prior to 1976 is unavailable. Interviews with former employees indicate the sludges were probably buried in the same general vicinity, that is, in front of the tunnel entrances. Also, the quantity may have been less than the amount removed in 1976.



SOURCE: INSTALLATION DOCUMENTS

POL Pipeline

The approximtely 16-mile pipeline system which connects the Waikakalaua and Kipapa storage facilities with Hickam AFB consists primarily of dual 10-inch diameter pipelines, with some short segments of 14- and 16-inch diameter. Several valve pits and surface stream/drainage crossings exist along the pipeline route. The pipes are steel and were coated, wrapped and provided with a cathodic protection system during installation. The oldest portion was constructed in 1943 and the latest addition was in 1959. Extensive lengths of pipeline were replaced in the 1950's. Maximum flow rate through the system is 70,000 gallons per hour and only one 10-inch line is used at any time.

The valve pits and above ground stream/ditch crossings along the pipeline are periodically inspected. The POL booster pump station is normally brought up to pressure against a closed valve at the end of the pipeline. Some leaks have been discovered when pressure and operating conditions have been abnormal.

Kokee AFS

Fuel storage at Kokee AFS consists of a tank for diesel (power plant) and a tank for MOGAS. Leakage assessment is by inventory control. The tanks have not been cleaned.

Spills and Leaks

Current and former employees were interviewed to determine the installation history concerning spills and leaks from fuel storage and pumping systems, waste accumulation areas, chemical delivery and handling, or other chemical/waste operations.

Bellows AFS, Punamano AFS, Waikakalaua POL and Kokee AFS

No significant spills or leaks were reported for Bellows AFS, Punamano AFS, Waikakalaua POL storage site and Kokee AFS.

Kaena Pt. STS

The only significant leak at Kaena Pt. occurred in 1972. About 1,800 gallons of diesel fuel was lost to the ground from the fuel storage/delivery system at the power generating plant (Building 39). There is no evidence of stress to vegetation in the area and no other indications of an impact from this leak.

Kipapa POL

One significant leak has occurred at the Kipapa POL storage site in about 1975. Fuel was inititally observed in the Kipapa Stream which passes adjacent to the storage site. This was traced back to a pipe leak near the entrance to the Tank No. 1 tunnel. Approximately 10,000 to 15,000 gallons of JP-4 was lost during this incident. The fuel soaked into the ground near the tunnel and apparently moved through the soil until it reached the Kipapa Stream (Figure 4.5). There is no remaining evidence of this leak from the standpoint of stressed vegetation.

POL Pipeline

The POL pipeline system used to convey fuels between the Waikakalaua and Kipapa storage areas and Hickam AFB has experienced numerous leaks (Figure 4.6). Leaks under 1,000 gallons have also occurred at valve pits and other appurtenances and these have normally been pumped out with the fuel recovered. Table 4.2 summarizes the significant fuel losses from the pipeline system. Most of the leaks have soaked into the ground without recovery; a few have involved discharge to surface waters. Where surface waters have been involved the fuel has been contained as much as possible. There is no surface evidence of the leak areas due to vegetative stress.

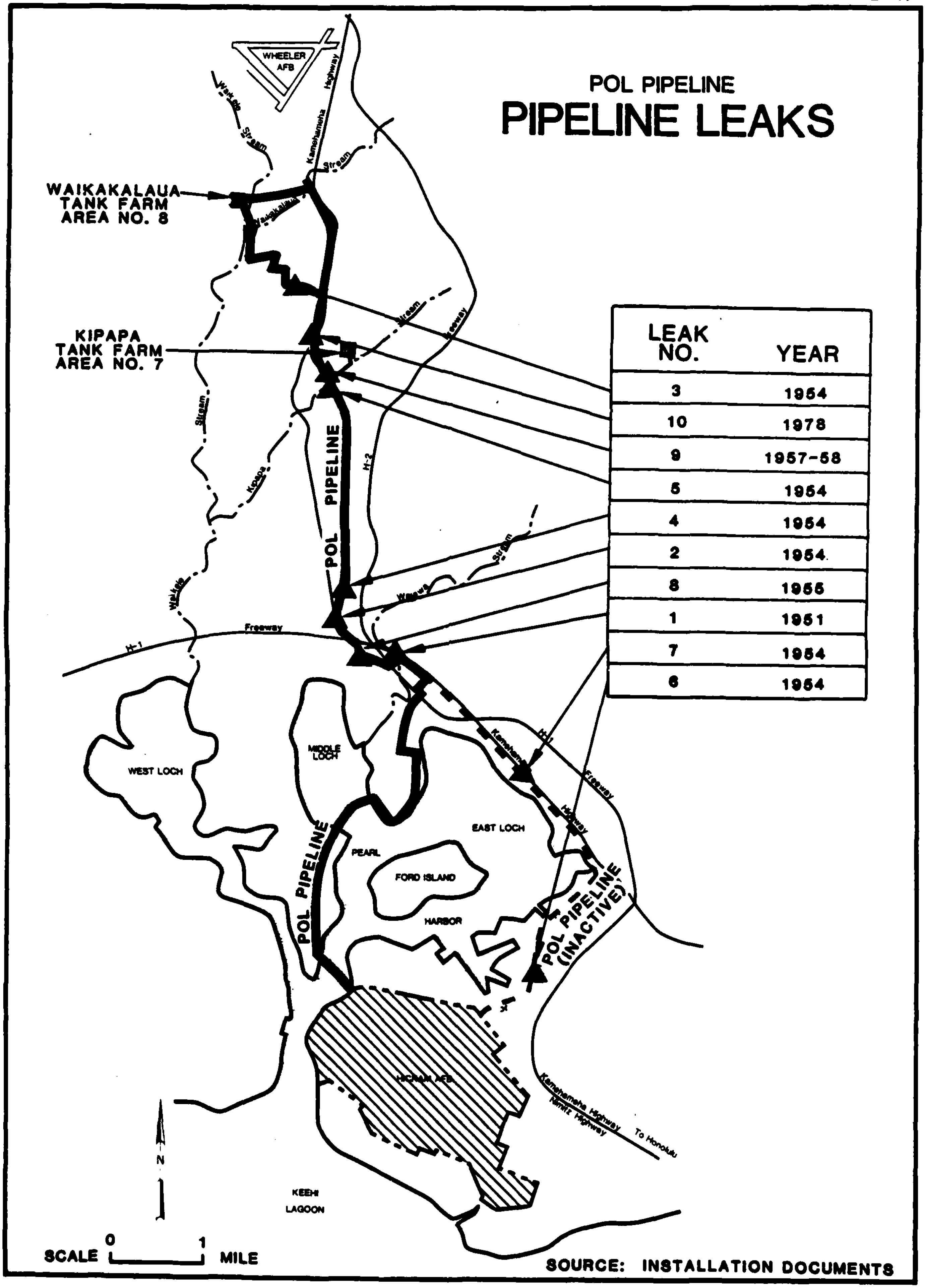
Pesticide Utilization

The use of pesticides at the 15th ABW Satellite Installations sites has been somewhat limited. Appendix D lists those pesticides currently being used.

Bellows AFS, Kaena Pt. STS, Punamano AFS and POL Storage Facilities

Off-base personnel have serviced Bellows AFS, Kaena Pt. STS, Punamano AFS, and the Hickam POL storage areas for pesticide control. Hickam AFB personnel have provided all the pesticide control applications for Bellows while Army personnel from Schofield Barracks have been handling the other installations noted previously since 1979. All makeup of pesticide solutions and cleaning of sprayers and pesticide containers has been done off these installations.

FIGURE 4.6



LEAK NO.	YEAR
3	1954
10	1978
9	1957-58
5	1954
4	1954
2	1954
8	1955
1	1951
7	1954
6	1954

TABLE 4.2
MAJOR POL PIPELINE LEAKS

Leak No.	Approximate Date	General Location	Approximate Fuel Loss	Notes*
1.	17 Jan. 1951	Vicinity of Waiawa Booster Station	10,000 gal AVGAS	Drained through nearby agricultural field to Waiawa Stream.
2.	15 Feb. 1954	North of Ewa Junction about 1/2 mile near Kamehameha Hwy. and Cane Haul Road	300,000 gal AVGAS	Drained to ground and Pearl Harbor.
3.	26 Aug. 1954	Line "B" in vicinity of Mililani Ditch Crossing between Waikakalaua and Kipapa Air Strip	70,000 gal AVGAS	Drained to ground in a cane field.
4.	9 Sep. 1954	One mile north Ewa Junction	86,000 gal AVGAS	-
5.	Sep. 1954	Kipapa Stream bed of the Kipapa Gulch	20,000 gal AVGAS	Pipe replaced on trestle over stream.
6.	6 Nov. 1954	Near Makalapa (Sub Base) Gate South of Halawa Stream	22,000 gal AVGAS	On currently inactive pipeline.
7.	18 Nov. 1954	In median of Kamehameha Hwy. one mile west of Aiea Junction near Waimalu Stream	20,000 gal AVGAS	On currently inactive pipeline.
8.	28 Oct. 1955	Near Ewa Junction	15,000 gal AVGAS	-
9.	1957-58	Kipapa Valve Pit	15,000 gal AVGAS	Drained into ground and to Kipapa Stream.
10.	Dec. 1978	At Kamehameha Hwy. Crossing Near Kipapa POL	50,000 gal JP-4	Drained into ground.

Source: 15th ABW historical records and interviews.

* There are no indications of major leaks in the 20-year period 1958-78 from historical data or long-term employees. A large extent of the original pipeline was abandoned and replaced in the 1950's which may have corrected the difficulties. In addition, fuel handling procedures have improved.

Kokee AFS

Kokee AFS has used a herbicide for only about six years. Solutions are mixed on the installation. Unrinsed containers (about one every year or two) are disposed off the installation.

Fire Protection Training

Kaena Pt. STS, Punamano AFS, Hickam POL storage areas and Kokee AFS have not had any fire training exercises that involved extinguishing fires. Bellows AFS has not had any training fires either, but the activities during the war years are uncertain.

INSTALLATION WASTE DISPOSAL METHODS

A review was made of the methods used to dispose of hazardous wastes on each 15th ABW Satellite Installation. Wastes disposed off the installation sites were excluded from the study. Information was obtained from installation files and employee interviews.

The facilities and methods used for disposal of hazardous wastes on the installations includes any or all of the following categories:

- o Landfills
- o Septic Tanks and Cesspools
- o Ground Application

Appendix F presents photographs of several disposal areas discussed.

Landfills

Kaena Pt. STS, Punamano AFS, Hickam POL Facilities and Kokee AFS

Landfills have not been used for disposal of wastes at Kaena Pt. STS, Punamano AFS, Hickman POL Facilities and Kokee AFS.

Bellows AFS

Only one landfill is known to have been used at Bellows AFS. A 1944 Bellows Field historical account notes the establishment of a "Post Dump" in the same general area as was used until the mid 1970's (Figure 4.1). An area fill operation was used. The landfill area appears to be approximately 3 acres.

In the period 1943 to about 1946, some shop wastes (oils, paints, thinners, etc.) were placed in a pit at the landfill. After these World

War II shops ceased operation (1945-46), no hazardous wastes went to the landfill; all have been transported to off-base locations. In the late 1960's to mid 1970's the landfill ceased operations. Occasionally in recent years it has been used for disposal of brush and bulky nonputrescible material. Material disposed at the landfill was routinely burned during the active operating years.

In addition to the landfill, a hardfill operation was utilized in the 1940's and 1950's (Figure 4.1). The hardfill received only construction and demolition material. The hardfill poses no potential for contamination.

Septic Tanks and Cesspools

Kaena Pt. STS, Punamano AFS, Hickam POL Facilities and Kokee AFS

Hazardous wastes are not known to have been disposed of in septic tanks and cesspools at Kaena Pt. STS, Punamano AFS, Hickam POL Facilities and Kokee AFS.

Bellows AFS

No information is available concerning the disposal methods for shops which operated from 1943 to 1946 at Bellows AFS. However, a 1943 drawing shows several shops connected to a septic tank and leaching pit. It is probable that some wastes (such as rinsewaters and other liquid residuals from industrial shops) were disposed to this system. Figure 4.1 shows the general area of the septic tank system.

Ground Application

Bellows AFS and Hickam POL Facilities

No wastes generated at Bellows AFS are known to have been disposed on the ground. The ground application of POL tank sludges was described earlier.

Kaena Pt. STS

As noted previously, some water used for rinsing parts at the power generating plant drains from a paved area at Building 39 to the ground. A small drainage channel connects with two small pits about 100 feet away, but the rinsewater generally seeps into the ground before reaching these pits.

Punamano AFS

During the late 1950's and early 1960's the HANG conducted periodic training exercises at Punamano AFS. In the 1960's a motor pool building was in use at the site (Figure 4.7). A couple of trucks received minor servicing at the facility while major maintenance was performed off-site. Motor oil was randomly dumped around the site during this period.

Kokee AFS

At Kokee AFS about 25 gallons of waste oil was applied each year during the period 1961-1974 along the perimeter since to contol weeds (Figure 4.3). The balance of the oil and other liquid wastes during this period was used for dust and weed control at locations off the installation. Residual paint thinners (about 5 gallons per year) have also been disposed of on the ground on a regular basis between Buildings 2 and 5.

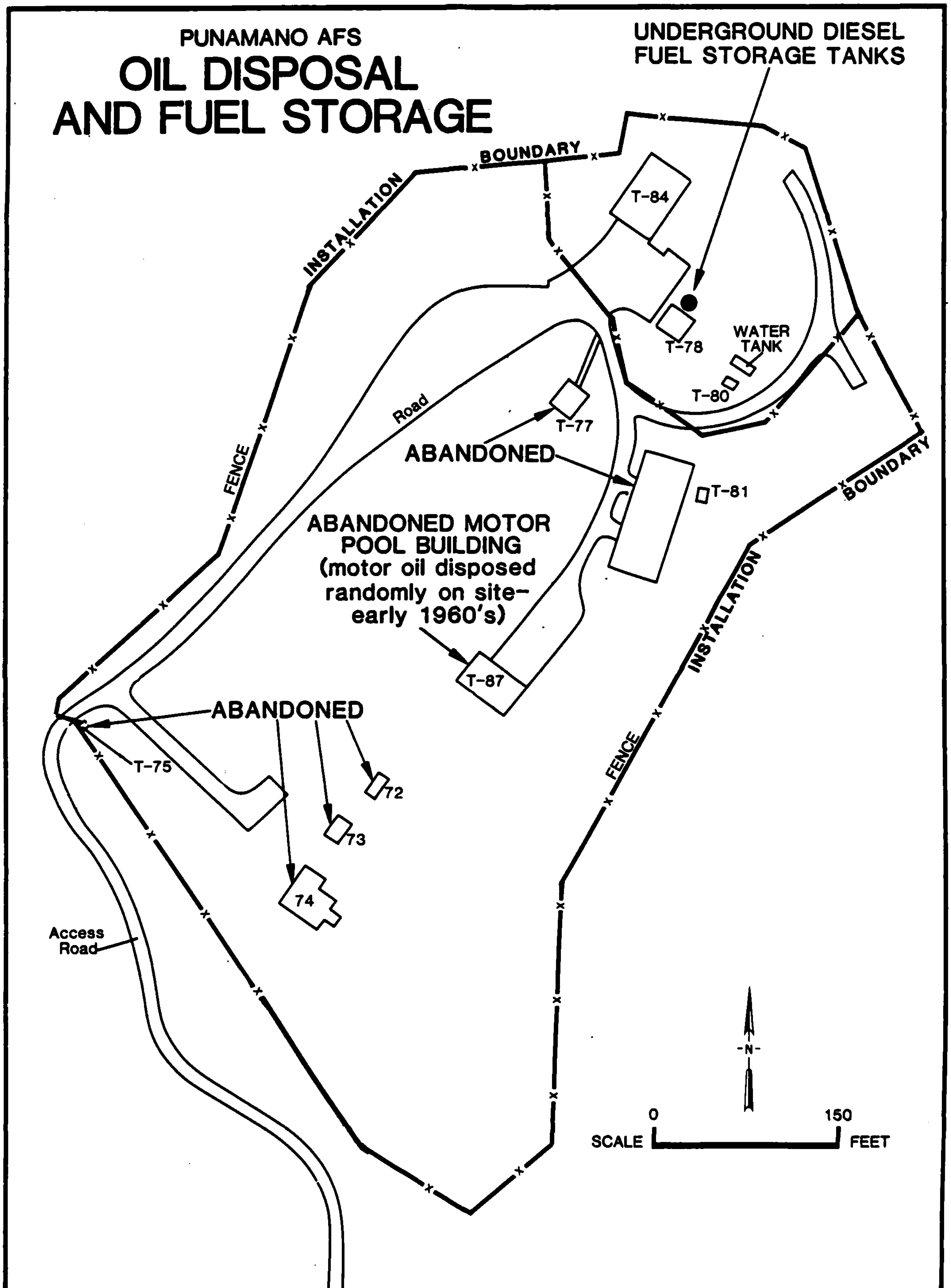
EVALUATION OF PAST DISPOSAL ACTIVITIES AND FACILITIES

Review of past waste generation and management practices at the 15th ABW Satellite Installations included in this study has resulted in identification of 18 sites and/or activities which were initially considered as areas of concern for potential hazards to health, welfare or the environment:

- Bellows AFS - 2
- Kaena Pt. STS - 1
- Punamano AFS - 1
- Waikakalaua POL Storage Area - 1
- Kipapa POL Storage Area - 1
- POL Pipeline - 10
- Kokee AFS - 2

Sites Eliminated from Further Evaluation

The sites of initial potential concern were evaluated considering specific waste disposal and site conditions and using the Flow Chart presented in Figure 1.2. Sites not considered to have a potential for contamination were deleted from further evaluation. The sites which have potential for contamination and migration of contaminants were evaluated using the Hazard Assessment Rating Methodology (HARM). Table 4.3 summarizes the results of the Flow Chart logic for each of the areas of initial concern.



SOURCE: INSTALLATION DOCUMENTS

TABLE 4.3
SUMMARY OF FLOW CHART LOGIC FOR AREAS OF INITIAL HEALTH, WELFARE AND ENVIRONMENTAL CONCERN AT 15TH ABW SATELLITE INSTALLATIONS

Site Description	Potential Hazard to Health, Welfare or Environment	Need for Further IRP Evaluation/ Action	HARM Rating
Bellows AFS			
Landfill	Yes	Yes	Yes
World War II Shop Area/Septic Tank System	Yes	Yes	Yes
Kaena Pt. Station			
Power Plant Site Tank Leak and Rinsewater	Yes	Yes	Yes
Punamano AFS			
Motor Pool Oil Disposal	No	No	No
Waikakalaua POL			
Sludge and Fuel Disposal on Entire Site	Yes	Yes	Yes
Kipapa POL			
Sludge Disposal and Pipe Leak Area	Yes	Yes	Yes
POL Pipeline			
Leak No. 1	Yes	Yes	Yes
Leak No. 2	Yes	Yes	Yes
Leak No. 3	Yes	Yes	Yes
Leak No. 4	Yes	Yes	Yes
Leak No. 5	Yes	Yes	Yes
Leak No. 6	Yes	Yes	Yes
Leak No. 7	Yes	Yes	Yes
Leak No. 8	Yes	Yes	Yes
Leak No. 9	Yes	Yes	Yes
Leak No. 10	Yes	Yes	Yes
Kokee AFS			
Oil Disposal (Fence)	No	No	No
Paint Thinner Disposal	No	No	No

Source: Engineering-Science

Three of the eighteen sites assessed did not warrant further evaluation. The rationale for omitting these sites from HARM evaluation is discussed below.

Punamano AFS

The disposal of small quantities of motor oil from the HANG operations at Punamano AFS occurred for only a few years. The oil is believed to have been spread on the ground at various locations at the site. Due to the waste characteristics, the small quantities disposal and the site characteristics, there is minimal potential for contamination. Thus this site was eliminated from further consideration.

Kokee AFS

The oil disposed along the perimeter fence was a small quantity dispersed over a large area. Oil disposed in this manner is no longer practiced. Similarly, disposal of paint thinners has involved a small quantity of waste. These practices are judged not to have significant potential for migration and contamination. Thus these two sites were eliminated from further evaluation.

Sites Evaluated Using HARM

The remaining 15 sites identified in Table 4.3 were evaluated using the Hazard Assessment Rating Methodology:

- Bellows AFS - 2
- Kaena Pt. STS - 1
- Waikakalaua POL - 1
- Kipapa POL - 1
- POL Pipeline - 10

The HARM evaluation takes into account characteristics of potential receptors, waste quantities and characteristics, pathways for migration of contaminants and site specific characteristics related to waste management practices. Results of the HARM analysis for the sites at the 15th ABW Satellite Installations are summarized in Table 4.4.

The procedures used in the HARM system are outlined in Appendix G and the specific rating forms for the sites that were evaluated are presented in Appendix H. The HARM system is designed to indicate the relative need for follow-on action.

TABLE 4.4
SUMMARY OF HARM SCORES FOR POTENTIAL CONTAMINATION SITES
AT 15TH ABW SATELLITE INSTALLATIONS

Site	Receptor Subscore	Waste Characteristic Subscore	Pathways Subscore	Waste Management	HARM Score
Bellows AFS					
Landfill	48	64	69	1.0	60
World War II Shop Area/ Septic Tank System	51	32	54	1.0	46
Kaena Pt. STS					
Power Plant Site - Tank Leak and Rinsewater	42	64	56	1.0	54
Waikakalaua POL					
Entire Site - Sludge and Fuel Disposal	72	80	67	1.0	73
Kipapa POL					
Sludge Disposal and Pipe Leak Area	72	80	74	1.0	75
POL Pipeline					
Leak No. 7	73	80	74	1.0	76
Leak No. 10	74	80	74	1.0	76
Leak No. 5	72	80	74	1.0	75
Leak No. 9	72	80	74	1.0	75
Leak No. 1	67	80	74	1.0	74
Leak No. 3	68	80	74	1.0	74
Leak No. 8	68	80	74	1.0	74
Leak No. 4	71	80	67	1.0	73
Leak No. 2	68	80	67	1.0	72
Leak No. 6	62	80	74	1.0	72

Source: Engineering-Science

SECTION 5
CONCLUSIONS

The goal of the IRP Phase I Study is to identify sites where there is potential for environmental contamination resulting from past waste disposal practices and to assess the probability of contaminant migration from these sites. The conclusions given below are based on field inspections; review of records and files; review of the environmental setting; interviews with present and former installation employees; and assessments using the HARM system. Table 5.1 contains a list of the potential contamination sources identified for the 15th ABW Satellite Installations and a summary of the HARM scores for all sites evaluated. Punamano AFS and Kokee AFS had no sites for potential contamination.

BELLOWS AFS

Landfill

This landfill site is judged to have sufficient potential to create environmental contamination and additional investigation is warranted. This landfill served Bellows AFS from the early 1940's until the mid 1970's. It did not receive any hazardous wastes in the 1950's to 1970's. The site received some hazardous materials from industrial shops located at the AFS from about 1943 to 1946. The receptor and waste characteristic subscores, resulted in a HARM score of 60.

World War II Shop Area/Septic Tank System

This site is concluded to have minimal potential to create environmental contamination and no additional investigation is warranted. Several shops were operated during the war years and may have had hazardous materials drained to the sewer/septic tank system in this area. The low receptors and waste characteristics subscores results in a final HARM score of 46.

TABLE 5.1
SITES EVALUATED USING THE HAZARD ASSESSMENT RATING METHODOLOGY
AT 15TH ABW SATELLITE INSTALLATIONS

Rank	Site	Operation Period	HARM Score[1]
	Bellows AFS		
1	Landfill	1940's-1970's	60
2	World War II Shop Area/ Septic Tank System	1943-1946	46
	Kaena Pt. STS		
1	Power Plant Site - Tank Leak and Rinsewater	1972 (Leak); 1965 - Present (Rinsewater)	54
	Waikakalaua POL		
1	Entire Site - Sludge and Fuel Disposal	1950-1975 (Sludge) 1943-Present (Fuel)	73
	Kipapa POL		
1	Sludge Disposal and Pipe Leak Area	1950-1976 (Sludge) 1975 (Leak)	75
	POL Pipeline		
1	Leak No. 7	1978	76
2	Leak No. 10	1957-58	76
3	Leak No. 5	1954	75
4	Leak No. 9	1957-58	75
5	Leak No. 1	1951	74
6	Leak No. 3	1954	74
7	Leak No. 8	1955	74
8	Leak No. 4	1954	73
9	Leak No. 2	1954	72
10	Leak No. 6	1954	72

(1) This ranking was obtained using the Hazard Assessment Rating Methodology (HARM) described in Appendix G. Individual rating forms are in Appendix H.

KAENA PT. STS

It is concluded this site has a minimal potential to create environmental contamination and no additional study is necessary. Kaena Pt. STS has had fuel from a diesel tank leak (1972) and rinsewater from parts cleaning (1965-present) drained to the ground adjacent to the power generating plant. The low receptors subscore resulted in a total HARM score of 54.

WAIKAKALAUA POL

The Waikakalaua POL storage site has sufficient potential to create environmental contamination and follow-on investigation is warranted. Sludge from fuel tank cleaning and contaminated fuels have been disposed on the site since construction in 1943. The final HARM score of 73 is primarily due to the quantity of wastes disposed and the site location with respect to wells, ground water recharge area and other receptor factors.

KIPAPA POL

The Kipapa POL storage site has sufficient potential to create environmental contamination and follow-on studies are justified. This storage site has had sludge obtained from cleaning the tunnel reservoirs disposed on the grounds since the original construction and has also experienced a pipe leak in the same area in 1975. The receptor subscore and the potential for surface water migration (pathway subscore) contributed to the total HARM value of 75.

POL PIPELINE

Leak No. 7

Leak No. 7 has sufficient potential to create environmental contamination to justify follow-on study. The leak of approximately 20,000 gallons of AVGAS in 1954 occurred on the currently inactive portion of the pipeline. The waste characteristics, receptors and pathway subscores all contribute to the HARM score of 76.

Leak No. 10

The site of Leak No. 10 has sufficient potential to create environmental contamination to justify follow-on study. The spill of about

50,000 gallons of JP-4 in 1978 primarily soaked into the ground even though a water course was located nearby. The quantity of fuel and the site location with respect to wells, ground water recharge, and populated areas are key elements in the total HARM score of 76.

Leak No. 5

Leak No. 5 has sufficient potential to create environmental contamination to warrant follow-on study. This approximate 20,000 gallon AVGAS leak from the POL pipe located under the Kipapa Stream bed occurred in 1954. The waste characteristics, receptors and pathways subscores all contribute to the HARM score of 75.

Leak No. 9

The fuel leak which occurred at this site (Leak No. 9) along the POL pipeline has sufficient potential to create environmental contamination to warrant follow-on investigation. The estimated 15,000 gallons of AVGAS that was discharged to the ground (1957-58) from the Kipapa Valve Pit soaked into the ground and also drained to Kipapa Stream. The location of the site near wells, adjacent to a surface stream and in a ground water recharge area contributes to the final HARM score of 75.

Leak No. 1

The site of Leak No. 1 has sufficient potential to create environmental contamination to warrant follow-on investigation. This spill of approximately 10,000 gallons of AVGAS in 1951 seeped into the ground and also flowed across an agricultural area to a nearby watercourse. The site location with respect to wells, ground water aquifer, and surface water contribute toward the final HARM score of 74.

Leak No. 3

This AVGAS pipeline leak site (No. 3) which occurred in 1954 has sufficient potential to create environmental contamination and additional study is warranted. The approximately 70,000 gallon leak site is within a ground water recharge area, near areas currently populated, and near surface waters. These factors contribute to the total HARM score of 74.

Leak No. 8

This leak site (No. 8) has sufficient potential to create environmental contamination to warrant follow-on investigation. An approximate 15,000 gallons of AVGAS leaked in 1955. The final HARM score was 74.

Leak No. 4

The approximate 86,000 gallon AVGAS leak site (No. 4) which occurred in 1954 has sufficient potential to create environmental contamination to justify follow-on study. The waste characteristic and receptor subscores contribute to a HARM score of 73.

Leak No. 2

The Leak No. 2 site has sufficient potential to create environmental contamination to warrant follow-on investigation. This leak of approximately 300,000 gallons of AVGAS occurred in 1954 and reached Pearl Harbor. The waste characteristics receptor, and pathway subscores contribute to the HARM score of 72.

Leak No. 6

The approximate 22,000 gallon AVGAS pipeline leak (No. 6) has sufficient potential to create environmental contamination to justify follow-on investigation. The leak occurred in 1954 on the currently inactive portion of the POL pipeline. The final HARM score was 72.

SECTION 6

RECOMMENDATIONS

Fifteen sites were identified at the 15th ABW Satellite Installations as having the potential for environmental contamination. These sites have been evaluated and rated using the HARM system which assesses their relative potential for contamination and provides the basis for determining the need for additional Phase II, IRP investigation. Thirteen of the fifteen sites have sufficient potential to create environmental contamination and warrant Phase II investigations. The sites evaluated have been reviewed concerning land use restrictions which may be applicable.

RECOMMENDED PHASE II MONITORING

The subsequent recommendations are made to further assess the potential for environmental contamination from waste disposal areas and leak/spill sites at the 15th ABW Satellite Installations. The recommended actions are sampling programs to determine if contamination does exist at the site. If contamination is identified in this first-step investigation, the Phase II sampling program will probably need to be expanded to define the extent and type of contamination. This may include geophysical testing and/or additional soil borings and monitoring wells, as well as additional analytical parameters. The recommended monitoring program is summarized in Table 6.1 and discussed below.

Bellows AFS

Landfill

Four monitoring wells are recommended for the landfill at Bellows AFS. One well should be located upgradient from the disposal site and three wells located downgradient. The upgradient well will serve as a control monitoring point. The parameters to be analyzed (Table 6.2) are intended as a screening approach to determine potential contamination.

More extensive analyses may be necessary if positive results are obtained in the initial sampling.

Hickam POL Facilities

Waikakalaua POL

It is recommended that approximately 15 soil borings and 6 soil samples (minimum) per boring be taken at the Waikakalaua POL storage area. Two borings should be taken in the 1975 sludge disposal area, 2 borings in other larger areas with vegetative stress, and 1 boring in smaller stressed areas. Four control borings located at strategic points away from the sludge/soil disposal areas (mainly along the northeastern and northwestern fence lines) should also be obtained. The soil samples should be analyzed for the parameters in Table 6.2. If shallow perched water is encountered, a well should be installed and the groundwater sampled (Table 6.2). If contamination is found in the borings, deeper sampling, geophysical surveys and/or more extensive site investigations may be required as a part of the Phase II program.

Kipapa POL

At the Kipapa POL storage area it is recommended that four borings be taken to determine the extent of contamination from the sludge disposal area and the 1975 pipe leak. Two borings should be taken in the sludge disposal area and one in the leak area near Kipapa Stream (Table 6.1). A control boring could be taken near the administration building. Deeper and more extensive sampling and possibly geophysical surveys, may be required if positive contamination results are obtained. If perched water is found during the boring program, water samples should be taken and analyzed (Table 6.2). Soil samples should be analyzed for the parameters in Table 6.2.

POL Pipeline

The extent of contamination from the pipeline leaks should be assessed by initially obtaining soil borings at the various sites (Table 6.1). Positive results from the initial borings may require deeper samples, additional borings, more extensive analytical testing and/or geophysical surveys to trace any subsurface plumes of fuel. The geophysical procedures will be more successful in the coastal areas than the upland portions of the pipeline route due to the more uniform geology. Borings for leaks in the coastal areas can also be somewhat

TABLE 6.1
RECOMMENDED MONITORING PROGRAM FOR PHASE II
IRP AT 15TH ABW SATELLITE INSTALLATIONS

Site (Rating Score)	Recommended Monitoring Program	Comments
Bellows AFS		
Landfill (60)	Install four monitoring wells, one upgradient and three downgradient from the landfill site. Construct well with Schedule 40 PVC and screen 10 to 20 feet into the upper aquifer. Sample and analyze the ground water for the parameters in Table 6.2.	Continue monitoring if sampling indicates contamination. Additional downgradient wells may be necessary to define the extent of contamination. A GC/MS scan may be run to identify any organic contaminants found.
Hickam POL Facilities		
Waikakalaua POL (73)	Obtain one to two soil borings in each of the areas with stressed vegetation and about four control borings on the site. Take 30-foot borings with samples collected at 5 foot intervals and at major soil interfaces. Fill and compact holes with clay. Analyze the soil samples for the parameters in Table 6.2. Conduct analyses on shallow samples first to determine the need for testing the deeper ones.	Take two borings in larger stressed areas and one in the smaller areas. If perched water is encountered install a well and analyze the water for the parameters in Table 6.2. If contamination is found at the bottom of the borings, deeper samples and more borings will be required to assess the extent of contamination.
Kipapa POL (75)	Obtain two soil borings in the sludge disposal area, one boring in the leak area between sludge disposal area and Kipapa Stream and one control boring. Take 30-foot borings with samples collected at 5-foot intervals and at major soil interfaces. Fill and compact holes with clay. Analyze the soil samples for the parameters in Table 6.2. Conduct analyses on shallow samples first to determine the need for testing the deeper ones.	If perched water is encountered install a well and analyze the water for the parameters in Table 6.2. If contamination is found at the bottom of the borings, deeper samples and more borings will be required to assess the extent of contamination.
POL Pipeline Leaks	Obtain an average of about five soil borings at each pipeline leak site. One boring at each site should be located to serve as a control. Take borings 30-feet deep in the upland areas and 20-feet deep in the coastal areas. Sample soil at 5-foot intervals and at major soil interfaces. Fill and compact holes with clay. Analyze the soil samples for the parameters in Table 6.2. Conduct analyses on shallow samples first to determine the need for testing the deeper ones.	Some leak areas may require six to eight borings and others three and four, depending upon the specific physical location for each site. If contamination is found at the bottom of the borings, deeper samples and more borings will be required to assess the extent of contamination.

Source: Engineering-Science.

TABLE 6.2

RECOMMENDED LIST OF ANALYTICAL PARAMETERS
FOR PHASE II IRP AT 15TH ABW SATELLITE INSTALLATIONS

Bellows Landfill - Water Samples

pH
Total Dissolved Solids
Oil and Grease
Total Organic Cárbon
Total Organic Halogens
Phenols
Lead

POL Areas - Soil Samples

Oil and Grease
Volatile Hydrocarbons
Ethylene Dibromide (EDB)
Lead

POL Areas - Water Samples

Oil and Grease
Total Organic Carbon
Volatile Hydrocarbons
Ethylene Dibromide (EDB)
Lead

Source: Engineering-Science

shallower than in the upland areas. The soil samples should be analyzed as listed in Table 6.2.

RECOMMENDED GUIDELINES FOR LAND USE RESTRICTIONS

It is desirable to have land use restrictions for the identified sites to (1) provide continued protection of human health, welfare, and environment; (2) insure that migration of potential contaminants is not promoted through improper land uses; (3) facilitate compatible development of future USAF facilities and (4) allow identification of property which may be proposed for excess or outlease.

The recommended guidelines for land use restrictions at each identified disposal site at the 15th ABW Satellite Installations are presented in Table 6.3. A description of the land use restriction guidelines is included in Table 6.4. Land use restrictions at sites recommended for on-site monitoring should be re-evaluated upon completion of the Phase II program and appropriate changes made.

TABLE 6.3
RECOMMENDED GUIDELINES AT POTENTIAL CONTAMINATION SITES FOR LAND USE RESTRICTIONS
15TH ABW SATELLITE INSTALLATIONS

	Recommended Guidelines for Future Land Use Restrictions[1]											
	Construction on the site	Excavation	Well construction on or near the site	Agricultural use	Silvicultural use	Water infiltration (run-on, ponding, irrigation)	Recreational use	Burning or ignition source	Disposal operations	Vehicular traffic	Material storage	Housing on or near the site
Bellows AFS												
Landfill	R	R	R	NR	R	R	NR	NR	R[2]	NR	NR	R
WWII Shop Area/Septic Tank System	NR	NR	R	NR	R	R	NR	NR	R[2]	NR	NR	R
Kaena Pt. STS												
Power Plant Site - Tank Leak and Rinsewater	NR	NR	R	NR	R	R	NR	NR	R	NR	NR	R
Waikakalaua POL												
Entire Site - Sludge and Fuel Disposal	R	R	R	R	R	R	NR	R	R	NR	NR	R
Kipapa POL												
Sludge Disposal and Pipe Leak Area	R	R	R	R	R	R	NR	R	R	NR	NR	R
POL Pipeline												
Leak Nos. 1 - 10	NR	NR	R	R	R	R	NR	R	NA	NR	NR	R

(1) See Table 6.4 for description of guidelines.
Note the following symbols in this table:

R = Restrict the use of the site for this purpose
NR = No restriction of the site for this purpose
NA = Not applicable.

(2) Restrict for all wastes except for construction/demolition debris.

Source: Engineering-Science

TABLE 6.4
DESCRIPTIONS OF GUIDELINES FOR LAND USE RESTRICTIONS

Guideline	Description
Construction on the site	Restrict the construction of structures which make permanent (or semi-permanent) and exclusive use of a portion of the site's surface.
Excavation	Restrict the disturbance of the cover or subsurface materials.
Well construction on or near the site	Restrict the placement of any wells (except for monitoring purposes) on or within a reasonably safe distance of the site. This distance will vary from site to site, based on prevailing soil conditions and ground-water flow.
Agricultural use	Restrict the use of the site for agricultural purposes to prevent food chain contamination.
Silvicultural use	Restrict the use of the site for silvicultural uses (root structures could disturb cover or subsurface materials).
Water infiltration	Restrict water run-on, ponding and/or irrigation of the site. Water infiltration could produce contaminated leachate.
Recreational use	Restrict the use of the site for recreational purposes.
Burning or ignition sources	Restrict any and all unnecessary sources of ignition, due to the possible presence of flammable compounds.
Disposal operations	Restrict the use of the site for waste disposal operations, whether above or below ground.
Vehicular traffic	Restrict the passage of unnecessary vehicular traffic on the site due to the presence of explosive material(s) and/or of an unstable surface.
Material storage	Restrict the storage of any and all liquid or solid materials on the site.
Housing on or near the site	Restrict the use of housing structures on or within a reasonably safe distance of the site.

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BIOGRAPHICAL DATA

Biographical Data

ROBERT L. THOEM
Civil/Environmental Engineer

PII Redacted

[redacted]

Education

B.S. Civil Engineering, 1962, Iowa State University, Ames, IA
M.S. Sanitary Engineering, 1967, Rutgers University, New Brunswick, NJ

Professional Affiliations

Registered Professional Engineer in six states
American Academy of Environmental Engineering (Diplomate)
American Society of Civil Engineers (Fellow)
National Society of Professional Engineers (Member)
Water Pollution Control Federation (Member)

Honorary Affiliations

Who's Who in Engineering
Who's Who in the Midwest
USPHS Traineeship

Experience Record

1962-1965 U.S. Public Health Service, New York, NY. Staff Engineer, Construction Grants Section (1962-1964). Technical and administrative management of grants for municipal wastewater facilities.

Water Resources Section Chief (1964-1965). Supervised preparation of regional water supply and pollution control reports.

1966-1983 Stanley Consultants, Muscatine, IA and Atlanta, GA. Project Manager and Project Engineer (1966-1973). Responsible for managing studies and preparing reports for a variety of industrial and governmental environmental projects.

Environmental Engineering Department Head (1973-1976). Supervised staff involved in auditing environmental practices, conducting studies and preparing reports concerning water and wastewater systems, solid waste and resource recovery and water resources projects (industrial and governmental).

Robert L. Thoem (Continued)

Resource Management Department Head (1976-1982). Responsible for multidiscipline staff engaged in planning and design of water and wastewater systems, solid waste and resource recovery, water resources, bridge, site development and recreational projects (industrial, domestic and foreign governments).

Associate Chief Environmental Engineer (1980-1983). Corporate-wide quality assurance responsibilities on environmental engineering planning projects.

Operations Group Head and Branch Office Manager (1982-1983). Directed multidiscipline staff responsible for planning and design of steam generation, utilities, bridge, water and wastewater systems, solid waste and resource recovery, water resources, site development and recreational projects (industrial, domestic and foreign governments). Administered branch office support activities.

Project Manager/Engineer for over 25 industrial projects, 25 city and county projects ranging in present study area population from 1,400 to 1,700,000, 10 regional (multi-county) planning or operating agency projects, five state agency projects, 10 projects for federal agencies, and several projects for Middle East governments.

1983-Date Engineering-Science. Senior Project Manager. Responsible for managing a variety of environmental projects. Conducted hazardous waste investigations at seven U.S. Air Force installations to identify the potential migration of contaminants resulting from past disposal practices under the Phase I Installation Restoration Program. Evaluated solid waste collection, disposal and potential for resource recovery at a U. S. Army post. Process selection and preliminary design studies and reports for expanding a municipal advanced wastewater treatment plant from 36 mgd to 54 mgd.

Publications and Presentations

Over thirteen presentations and/or papers in technical publications dealing with solid waste, sludge, water, wastewater and project cost evaluations.

Biographical Data

JOHN R. ABSALON
Hydrogeologist

PII Redacted

[redacted]

Education

B.S. in Geology, 1973, Upsala College, East Orange, New Jersey

Professional Affiliations

Certified Professional Geologist (Indiana No. 46, Virginia No. 241)
Association of Engineering Geologists
Geological Society of America
National Water Well Association

Experience Record

1973-1974 Soil Testing Incorporated-Drilling Contractors, Seymour, Connecticut. Geologist. Responsible for the planning and supervision of subsurface investigations supporting geotechnical, ground-water contamination, and mineral exploitation studies in the New England area. Also managed the office staff, drillers, and the maintenance shop.

1974-1975 William F. Loftus and Associates, Englewood Cliffs, New Jersey. Engineering Geologist. Responsible for planning and management of geotechnical investigations in the northeastern U.S. and Illinois. Other duties included formal report preparation.

1975-1978 U.S. Army Environmental Hygiene Agency, Fort McPherson, Georgia. Geologist. Responsible for performance of solid waste disposal facility siting studies, non-complying waste disposal site assessments, and ground-water monitoring programs at military installations in the southeastern U.S., Texas, and Oklahoma. Also responsible for operation and management of the soil mechanics laboratory.

1978-1980 Law Engineering Testing Company, Atlanta, Georgia. Engineering Geologist/Hydrogeologist. Responsible for the project supervision of waste management, water quality assessment, geotechnical, and hydrogeologic studies at commercial, industrial, and government facilities. General experience included planning and management of several ground-water monitoring programs.

John R. Absalon (Continued)

development of remedial action programs, and formulation of waste disposal facility liner system design recommendations. Performed detailed ground-water quality investigations at an Air Force installation in Georgia, a paper mill in southwestern Georgia, and industrial facilities in Tennessee.

1980-Date Engineering-Science. Hydrogeologist. Responsible for supervising efforts in waste management, solid waste disposal, ground-water contamination assessment, leachate generation, and geotechnical and hydrogeologic investigations for clients in the industrial and governmental sectors. Performed geologic investigations at twelve Air Force bases and other industrial sites to evaluate the potential for migration of hazardous materials from past waste disposal practices. Conducted RCRA ground-water monitoring studies for industrial clients and evaluated remedial action alternatives for a county landfill in Florida. Conducted quality management, hydrogeologic and ground-water quality programs for the pulp and paper industry at several mills located in the Southeast United States.

Publications and Presentations

"Practical Aspects of Ground-Water Monitoring at Existing Disposal Sites," 1980, coauthor: R.C. Starr, Proceedings of the EPA National Conference on Management of Uncontrolled Hazardous Sites, HMCRI, Silver Spring, MD.

"Improving the Reliability of Ground-Water Monitoring Systems," 1981, Proceedings of the Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, University of Wisconsin-Extension, Madison, WI.

"Identification and Treatment Alternatives Evaluation for Contaminated Ground Water," 1982, coauthor: M. R. Hockenbury. Presented to Association of Engineering Geologists Symposium on Hazardous Waste Disposal, Atlanta, 17 September.

"Preliminary Assessment of Past Waste Storage and Disposal Sites," 1982, coauthor: W. G. Christopher. Presented to Association of Engineering Geologists Symposium on Hazardous Waste Disposal, Atlanta, 17 September.

"Treatment Alternatives Evaluation for Aquifer Restoration," 1983, coauthor: M. R. Hockenbury, Proceedings of the Third National Symposium on Aquifer Restoration and Ground Water Monitoring, NWWA, Worthington, OH.

BIOGRAPHICAL DATA

Rocco M. Palazzolo
Environmental Engineer

PII Redacted

[redacted]

Education

B.S. in Civil Engineering, Wayne State University, 1981
M.S. in Environmental Engineering, Georgia Institute of Technology, 1983.

Professional Affiliations

Water Pollution Control Federation

Honorary Affiliation

Tau Beta Pi

Experience Record

1974-1976 — R. D. Palazzolo Associates, Consulting Engineers, P.C., Detroit, Michigan. Engineering Assistant responsible for vendor follow-up during expansion of an transmission manufacturing plant. Acted as liaison between automobile manufacturer and vendors of machine tools, fixtures, gages, etc. Duties included preparation of weekly progress reports, maintenance of records, informing vendors of design changes, etc.

1978-1981 — R. D. Palazzolo Associates, Consulting Engineers, P.C., Detroit, Michigan. Checked designs of machine tools, fixtures, gages, and materials handling equipment. Also served as Manufacturers' Representative for tool and die shops.

1981-1983 — Georgia Institute of Technology, Atlanta, GA. Graduate Research Assistant in projects including development of a means to improve hydraulic behavior of fluidized bed reactors, review and experimental testing of hydraulic models of fluidization and sedimentation, and a study of absorption enhanced anaerobic treatment of coal gassification wastewater. Responsible for design and construction of experimental apparatus, system operation and maintenance, experimental measurements and analyses, review of

Rocco M. Palazzolo

data and preparation of reports. Also taught undergraduate classes in water distribution and sewer system collection design.

1983-Date — Engineering-Science, Inc., Atlanta, GA. Project Engineer responsible for preparation of a RCRA Part B Permit Application. Work included review of hazardous waste management practices and facilities at the plant for compliance with federal and state regulations. Hazardous waste management processes included container and tank storage, disposal in an on-site secure landfill, and treatment by incineration.

Project Engineer responsible for investigation of environmental impact of a closed garbage and rubbish landfill on a proposed apartment development, including investigation of pollution of ground water and surface water in a nearby stream. Work included development of the history of the landfill, field sampling and measurements, review of data, and presentation of recommendations.

Publications

Khudenko, B.M. and Palazzolo, R.M. "Hydrodynamics of Fluidized Bed Reactors for Wastewater Treatment". Proceedings: First International Conference on Fixed Film Biological Processes, April 20-23, 1982, Kings Island, Ohio, Vol. 3, pp. 1288-1334.

Palazzolo, R.M. and Khudenko, B.M. "Development of A New Type of Fluidized Bed Reactor". International Conference on Scale-up of Water and Wastewater Treatment Processes, March 17 and 18, 1983, Edmonton, Alberta, Canada.

APPENDIX B

LIST OF INTERVIEWEES AND OUTSIDE AGENCY CONTACTS

TABLE B.1

LIST OF INTERVIEWEES

Most Recent Position	Years of Service
Bellows AFS	
1. Accounting Clerk	40
2. Manager, Recreation Center	19
3. NCOIC, CE	3
4. NCO, Supply	2
5. NCOIC, Operating Location Chief, 1957 Comm. Group	2
6. Assistant NCOIC, Diesel Power Section, 1957 Comm. Group	2
7. Radio Technician, 1957 Comm. Group	27
8. Unit Administrator, HARNG	15
9. Heavy Equipment Operator	5
10. Truck Operator	7
11. Motor Pool Mechanic	2
12. CE Shop Foreman	3
13. Former Base Commander, Nike Missile Site	5
14. Former Work Leader, Roads and Grounds, Plumbing and Electric	32
15. Former Vehicle Mechanic	11
Kaena Pt. STS	
1. OIC	1
2. Chief of Support	20
3. Supply Supervisor	6
4. Branch Supervisor	14
5. Power Plant Work Leader	17
6. Maintenance Work Leader	6
7. Supervisor, Land Management Branch, Schofield Barracks	34
Punamano AFS	
1. Site Supervisor	2
2. NCO, Training	2
3. High Voltage Electrician, Schofield Barracks	6
4. Water Plant Section Foreman, Schofield Barracks	21
5. Former Detachment Commander	2
6. Former Radio Technician	2
7. Pest Control Foreman, Schofield Barracks	34

TABLE B.1 (Continued)

LIST OF INTERVIEWEES

Most Recent Position	Years of Service
Waikakalaua and Kipapa POL	
1. Foreman, Fuels Operations	11
2. NCOIC, Liquid Fuels Maintenance	5
3. NCO, Liquid Fuels Maintenance	1
4. Mechanic, Liquid Fuels Maintenance	16
5. Mechanic, Liquid Fuels Maintenance Shop	22
6. Former Supervisor, POL Facilities	25
7. Terminal Foreman, Waikakalaua and Kipapa POL	11
8. Former Terminal Foreman, Waikakalaua and Kipapa POL	28
Kokee AFS	
1. Supervisor, Quality Control	24
2. Supervisor, Maintenance Control	21
3. Foreman, Motor Pool	24
4. Maintenance Mechanic	25
Hickam AFB	
1. Chief, Real Estate Branch	34
2. NCOIC, Bioenvironmental Engineering Services	3
3. NCO, Bioenvironmental Engineering Services	1

TABLE B.2

OUTSIDE AGENCY CONTACTS

1. U.S. Environmental Protection Agency, Region IX
   Pacific Islands Contact Office
   300 Ala Moana Boulevard, Room 1302
   Honolulu, Hawaii 96813
   Vicki H. Tsuhako, Information Specialist (808/546-8910)

2. U.S. Environmental Protection Agency, Region IX
   Mailstop T-4-1
   214 Freemont Street
   San Francisco, California 94105
   Marvin Young, Regional Site Project Officer (415/974-8916)

3. U.S. Department of Agriculture
   Soil Conservation Service
   300 Ala Moana Boulevard, Room 3120
   Honolulu, Hawaii 96850
   Stanley J. Souza, Soil Conservation Technician (808/546-8328)

4. U.S. Geological Survey
   Water Resources Division
   300 Ala Moana Boulevard, Room 6110
   Honolulu, Hawaii 96850
   Dan A. Davis, District Chief (808/546-8333)
   Kiyoshi Takasaki, Hydrologist
   Charles D. Hunt, Hydrologist
   Paul R. Eyre, Hydrologist
   Johnson Yee, Chemist
   Rose Maruoka, Records Specialist

5. Hawaii Department of Health
   645 Halekauwila Street
   Honolulu, Hawaii 96813
   Edward N. Yamada, Environmental Engineer, Permits Branch (808/548-6410)
   Thomas E. Arizumi, Chief, Drinking Water Section (808/548-2235)

6. Honolulu Board of Water Supply
   630 South Beretania Street
   Honolulu, Hawaii 96843
   Chester Lao, Head, Hydrology-Geology Section (808/527-5276)
   Lawrence Whang, Head Environmental Section (808/527-6138)

APPENDIX C

TENANT ORGANIZATIONS AND MISSIONS

APPENDIX C

TENANT ORGANIZATIONS AND MISSIONS

The 15th ABW is the host unit at all of the satellite installations in this report. Following are the major assigned/supported units and tenants at each installation.

BELLOWS AFS

1957th Communications Group, Operating Location-A (OL-A)

The 1957th Communications Group, (Air Force Communications Command) maintains a communications transmitter facility which provides ground-to-air communications for military aircraft and aircraft transporting high government officials.

1st Marine Brigade Detachment

Bellows AFS is used by the Marine Detachment for amphibious, helicoptor, vehicle and other training for personnel stationed at nearby Kaneohe Marine Corps Air Station.

291st Maintenance Co., Hawaii Army National Guard

The National Guard unit maintains facilities and equipment for training personnel.

KAENA PT. STS

Detachment 6, Air Force Satellite Control Facility (AFSCF)

This unit is a part of the Air Force Systems Command's Space Division. The Detachment, one of several worldwide units, is responsible for on-orbit control and evaluation of DOD space vehicles. The Kaena Point Station is utilized for tracking, commanding and processing orbital data under the direction of Det. 6 AFSCF.

WSMC/Federal Electronics Corp. (ITT)

This contractor is reponsible for AFSCF operations in Building 41, the tracking equipment at the northern edge of the installation.

U.S. Army

Army personnel for Schofield Barracks are assigned to Kaena Point and have maintenance responsibilities at the installation.

PUNAMANO AFS

1891st Communications Squadron

This unit, an Air Force Communications Service organization from Wheeler AFB, operates the Punamano AFS. It provides a communications link with the PACAF Command Control Radio Network.

KOKEE AFS

150th Aircraft Control and Warning Squadron, Hawaii Air National Guard

This unit is headquartered at Kokee AFS and operates the facility. The primary mission is radar detection, identification and interception. Aircraft from Hickam AFB's 199th Tactical Fighter Squadron of the Hawaii Air National Guard are used for interception.

OTHER ORGANIZATIONS

Other tenant organizations found at some of the 15th ABW satellite sites include:

- Army-Air Force Exchange Service
- State of Hawaii
- City and County of Honolulu
- University of Hawaii
- Hawaiian Telephone Co.
- Hawaiian Electric Co.
- Kauai Electric Co.
- Civil Air Patrol
- Civil Defense
- FAA
- U.S. Coast Guard

APPENDIX D

SUPPLEMENTAL BASE FINDINGS INFORMATION

TABLE D.1

PESTICIDES CURRENTLY USED
15TH ABW SATELLITE SITES

		Type	Use	Current Approximate Annual Quantity
Bellows	-	Roundup	Herbicide	50 gal.
		Rodeo	Herbicide	20 gal.
		Fenamine	--	50 gal.
Kaena Pt.	-	Warfin	Rodenticide	60 lb.
		Diazinon	Insecticide	120 gal.
Punamano	-	Warfin	Rodenticide	60 lb.
		Diazinon	Insecticide	120 gal.
Kipapa	-	Roundup	Herbicide	1 gal.
Waikakalaua	-	Roundup	Herbicide	1 gal.
Kokee	-	Roundup	Herbicide	5 gal.

TABLE D.2

LIQUID FUEL AND WASTE OIL TANKS
15TH ABW SATELLITE SITES

Facility	Material Stored	No. of Tanks	Total Storage Capacity (gal)	Above or Below Ground	Diked or Undiked
Bellows	Mogas	2	12,000	Below	NA
	Diesel	1	600	Above	Undiked
	Diesel	4	100,000	Below	NA
	Waste Oil (1)	1	300	Below	NA
	Mogas or Diesel (2)	2	800	Above	Undiked
	Abandoned (Avgas) (3)	12	600,000	Below	NA
	Abandoned (Diesel) (3)	1	6,000	Below	NA
Kaena Pt.	Diesel	2	40,000	Below	NA
	Mogas	4	2,000	Below	NA
Punamano	Diesel	2	1,000	Below	NA
Kipapa	JP-4	4	10,000,000	Below	NA
	Diesel	1	500	Below	NA
Waikakalaua	JP-4	9	15,750,000	Below	NA
	Diesel	1	600	Below	NA
Kokee	Diesel	1	15,000	Below	NA
	Mogas	1	2,000	Below	NA

(1) Receives other waste fluids in addition to oil.
(2) Tanks on wheeled trailers - National Guard portable units.
(3) No data on method of abandonment.
NA = Not applicable.

TABLE D.3

PCB AND PCB-CONTAMINATED TRANSFORMERS IN SERVICE
AT 15TH ABW SATELLITE SITES

Facility	Transformers
Bellows	None known to exist but all transformers have not been tested.
Kaena Pt.	PCB >500 ppm for transformer Serial No. E687253 (225 KVA) located at Building 13.
Punamano	None known to exist but all transformers have not been tested.
Kipapa	None known to exist but all transformers have not been tested.
Waikakalaua	None known to exist but all transformers have not been tested.
Kokee	None known to exist but all transformers have not been tested.

TABLE D.4
UNIFIED SOIL CLASSIFICATION

Major Division		Group Symbol	Laboratory Classification Criteria: Finer than 200 Sieve (%)	Laboratory Classification Criteria: Supplementary Requirements	Soil Description
Coarse-grained (over 50% by weight coarser than No. 200 sieve	Gravelly soils (over half of coarse fraction larger than No. 4)	GW	0-5*	D_{60}/D_{10} greater than 4 $D_{30}^2/(D_{60} \times D_{10})$ between 1 & 3.	Well-graded gravels, sandy gravels.
		GP	0-5*	Not meeting above gradation for GW.	Gap-graded or uniform gravels, sandy gravels.
		GM	12 or more*	PI less than 4 or below A-line.	Silty gravels, silty sandy gravels.
		GC	12 or more*	PI over 7 and above A-line.	Clayey gravels, clayey sandy gravels.
	Sandy soils (over half of coarse fraction finer than No. 4)	SW	0-5*	D_{60}/D_{10} greater than 4 $D_{30}^2/(D_{60} \times D_{10})$ between 1 & 3.	Well graded, gravelly sands.
		SP	0-5*	Not meeting above gradation requirements.	Gap-graded or uniform sands, gravelly sands.
		SM	12 or more*	PI less than 4 or below A-line.	Silty sands, silty gravelly sands.
		SC	12 or more*	PI over 7 and above A-line.	Clayey sands, clayey gravelly sands.
Fine-grained (over 50% by weight finer than No. 200 sieve	Low compressibility (liquid limit less than 50)	ML	-	Plasticity chart	Silts, very fine sands, silty or clayey fine sands, micaceous silts.
		CL	-	Plasticity chart	Low plasticity clays, sandy or silty clays.
		OL	-	Plasticity chart, organic odor or color.	Organic silts and clays or low plasticity.
	High compressibility (liquid limit more than 50)	MH	-	Plasticity chart	Micaceous silts, diatomaceous silts, silts, volcanic ash.
		CH	-	Plasticity chart	Highly plastic clays and sandy clays.
		OH	-	Plasticity chart, organic odor or color.	Organic silts and clays of high plasticity.
Soils with fibrous organic matter		Pt	-	Fibrous organic matter; will char, burn, or glow.	Peat, sandy peats, and clayey peat.

*For soils having 5 to 12% passing the No. 200 sieve, use a dual symbol such as GW-GC.

Source: U.S. Waterways Experiment Station and ASTM D-2487-690.

TABLE D.5
ENDANGERED AND THREATENED ANIMALS AND PLANTS OF HAWAII

	Common Name [Hawaiian Name]	Scientific Name	Known Breeding Range***	Area of Distribution Where Endangered or Threatened
Birds				
*1.	Newell Shearwater ['A'o]	Puffinus auricularis newelli	H, Mo, K	Entire
2.	Hawaiian [Dark-rumped] Petrel ['Ua'u]	Pterodroma phaeopygia sandwichensis	H, M, L	"
**3.	Hawaiian [Band-rumped] Storm-Petrel ['Oe'oe]	Oceanodroma castro cryptoleucure	K	"
4.	Hawaiian Goose [Nene]	Nesochen sandvicensis	H, M	"
5.	Laysan Duck	Anas laysanensis	Laysan Isl.	"
6.	Hawaiian Duck [Koloa-maoli]	Anas wyvilliana	H, O, K, N	"
7.	Hawaiian Hawk ['Io]	Buteo solitarius	H	"
8.	Hawaiian (Common Moorhen) Gallinule ['Alae-'ula]	Gallinula chloropus sandvicensis	O, K	"
9.	Hawaiian Coot ['Alae-ke'oke'o]	Fulica americana alai	H, M, Mo, O, K, N	"
10.	Hawaiian (Black-necked) Stilt ['Ae'o]	Himantopus mexicanus knudseni	H, M, Mo, O, K, N	"
**11.	Hawaiian (Short-eared) Owl [Pueo]	Asio flammeus sandwichensis	H, M, Mo, L, O, K, N	O
**12.	White (Fairy) Tern [Manu-o-Ku]	Gygis alba rothschildi	O, Leeward Isls.	O
13.	Hawaiian Crow ['Alala]	Corvus hawaiiensis	H	Entire
14.	Small Kauai Thrush [Puaiohi]	Phaeornis palmeri	K	"
15.	Kauai Thrush [Kama'o]	Phaeornis obscurus myadestina	K	"
16.	Molokai Thrush [Oloma'o]	Phaeornis obscurus rutha	Mo	"
17.	Nihoa Millerbird	Acrocephalus familiaris kingi	Nihoa Is.	"
18.	Kauai 'O'o ['O'o 'a'a]	Moho braccatus	K	"
**19.	Maui 'Amakihi	Hemignathus virens wilsoni	M, Mo, L	L
20.	Hawaii Creeper	Oreomystis mana	H	Entire
21.	Molokai Creeper [Kakawahie]	Paroreomyza flammea	Mo	"
22.	Oahu Creeper ['Alauwahio]	Paroreomyza maculata	O	"
23.	Hawaii 'Akepa	Loxops coccineus coccineus	H	"
24.	Maui 'Akepa	Loxops coccineus ochraceus	M	"
25.	[Po'ouli]	Melamprosops phaeosoma	M	"
26.	Kauai 'Akialoa	Hemignathus procerus	K	"
27.	Maui Nuku-pu'u	Hemignathus lucidus affinis	M	"
28.	Kauai Nuku-pu'u	Hemignathus lucidus hanapepe	K	"
29.	['Akiapola'au]	Hemignathus munroi	H	"
30.	Maui Parrotbill	Pseudonestor xanthophrys	M	"
31.	['O'u]	Psittirostra psittacea	H, K	"
32.	Laysan Finch	Telespyza cantans	Laysan Isl.	"
33.	Nihoa Finch	Telespyza ultima	Nihoa Isl.	"
34.	[Palila]	Loxioides bailleui	H	"
35.	Crested Honeycreeper ['Akohekohe]	Palmeria dolei	M	"
**36.	['I'iwi]	Vestiaria coccinea	K, M, H, Mo, O	O, L, Mo

TABLE D.5 (Continued)
ENDANGERED AND THREATENED ANIMALS AND PLANTS OF HAWAII

Common Name [Hawaiian Name]	Scientific Name	Known Breeding Range***	Area of Distribution Where Endangered or Threatened
Mammals			
1. Hawaii bat ['Ope'ape'a]	Lasiurus cinereus semotus	H, K	Entire
2. Hawaiian seal ['Ilio-holo'i-kauaua]	Monachus schauinslandi	Leeward Isls.	"
3. Humpback whale	Megaptera novaeangliae	Oceanic	"
4. Fin or Finback whale	Balaenoptera physalus	Oceanic	"
5. Sperm whale	Physeter catodon	Oceanic	"
Reptiles			
*1. Pacific green sea turtle [Honu]	Chelonia mydas agassizi	Oceanic	Entire
2. Pacific hawksbill turtle [Ea]	Eretmochelys imbricata bissa	Oceanic	"
3. Pacific leatherback sea turtle	Dermochelys coriacea schlegelii	Oceanic	"
Mollusks			
1. Oahu tree snails [Pupu kanioe or Pupu kuahiwi]	Achatinella spp.	O	Entire
Plants			
1. Hawaiian vetch	Vicia Mensiesii Spreng.	H	Entire
2.	Stenogyne angustifolia Gray var. angustifolia	H	"
3.	Haplostachys haplostachya (Gray) St. John var. angustifolia (Sherff) St. John	H	"
4. [Nehe]	Lipochaeta venosa Sherff var.	H	"
5. Cooke kokia [Koki'o]	Kokio Cookei Deg.	Mo (Known in cultivation on Oahu only)	"
6. 'Ewa Plains 'akoko	Euphorbia Skottsbergii Sherff var. kalaeloana Sherff	O	"
7. Carter's panicgrass	Panicum carteri Hosaka	islet off Oahu	"

TABLE D.5 (Continued)
ENDANGERED AND THREATENED ANIMALS AND PLANTS OF HAWAII

	Common Name [Hawaiian Name]	Scientific Name	Known Breeding Range***	Area of Distribution Where Endangered or Threatened
8.	Cuneate Bidens	_Bidens cuneata_ Sherff	O	*
9.	Diamond Head schiedea	_Schiedea adamantis_ St. John	O	*

* = Listed as Threatened
** = Listed as Endangered by State of Hawaii only
*** = Island Key

H = Hawaii		O = Oahu	
M = Maui		K = Kauai	
Mo = Molokai		N = Niihau	
L = Lanai			

Note: Unless otherwise noted, all species listed herein are considered to be endangered by both the federal and state governments.

REFERENCES

Anon. 1982. State of Hawaii, Department of Land and Natural Resources. Title 13, Subtitle 5 Forestry and Wildlife, Chapter 124: Rules Regulating the Management and Protection of Indigenous Wildlife, Endangerd and Threatened and Threatened Wildlife and Plants, and Introduced Wild Birds. 6 pp, Exhibits 1-4.

____. 1982. Department of the Interior, Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 and 17.12. 13 pp.

____. 1982. Department of the Interior, Fish and Wildlife Service, Federal Register of August 24. Vol. 47, No. 164.

Birds

Pyle, R.L. 1983. Checklist of the Birds of Hawaii. Hawaii Audubon Society, P.O. Box 22832, Honolulu, Hawaii 96822.

Mammals

Shallenberger, E.W. 1979. The Status of Hawaiian Cetaceans. Prepared on contract to the U.S. Marine Mammal Commission. Manta Corp., Kailua. 103 pp.

Reptiles

McKeown, S. 1978. Hawaiian Reptiles and Amphibians. The Oriental Publishing Co., Honolulu. 80 pp.

Plants

Ayensu, E.S. & R.A. DeFilipps. 1978. Endangered and Threatened Plants of the United States. Smithsonian Institution/World Wildlife Fund, Inc. Washington, D.C. 301 p.

Updated Nov. 1983 - (1776B/54)

TABLE D.6
MUNICIPAL AND HIGH-CAPACITY WATER WELLS
IN USE NEAR POL PIPELINE AND POL FACILITIES

Local No.	Old No.	Name	Use	Depth (feet)
3-2201-03	W257-A	Schof. Brks.	Irrigation	230.00
3-2201-04	W257-B	Schof. Brks.	Irrigation	226.00
3-2201-07	W257-C	Schof. Brks.	Irrigation	282.00
3-2201-11	W255-1	Puuloa	Domestic	175.00
3-2201-13	W255-2	Puuloa	Domestic	200.00
3-2202-21	S3	Schof. Brks.	Irrigation	156.00
3-2203-01	W274-A	Schof. Brks.	Irrigation	213.00
3-2203-02	W274-B	Schof. Brks.	Irrigation	158.00
3-2203-03	W274-C	Schof. Brks.	Irrigation	263.00
3-2203-04	W274-D	Schof. Brks.	Irrigation	233.00
3-2203-05	W274-E	Schof. Brks.	Irrigation	246.00
3-2203-06	W274-F	Schof. Brks.	Irrigation	197.00
3-2254-01	S11	Puuloa	Public Supply	210.00
3-2254-02	W178-2	Puuloa	Public Supply	164.00
3-2255-05	W178	Puuloa	Irrigation	545.00
3-2255-32	S5	Waipahu	Public Supply	99.00
3-2255-36	W189-3B	Waipahu	Domestic	240.00
3-2255-37	W189-4A	Waipahu	Public Supply	345.00
3-2255-38	W189-4B	Waipahu	Public Supply	359.00
3-2255-39	W189-4C	Waipahu	Public Supply	399.00
3-2300-05	W245	Waipahu	Domestic	--
3-2300-07	W246-A	Waipahu	Irrigation	--
3-2300-11	W238	Waipahu	Irrigation	202.00
3-2300-17	W246-H	Waipahu	Irrigation	430.00
3-2300-19	253-1	Waipahu	Institutional	131.00
3-2300-20	238-1	Waipahu	Irrigation	204.00
3-2301-05	W247-E	Waipahu	Public Supply	410.00
3-2301-09	W247-I	Waipahu	Irrigation	490.00
3-2301-10	W247-J	Waipahu	Irrigation	498.00
3-2301-14	W248-D	Waipahu	Irrigation	500.00

TABLE D.6 (Continued)
MUNICIPAL AND HIGH-CAPACITY WATER WELLS
IN USE NEAR POL PIPELINE AND POL FACILITIES

Local No.	Old No.	Name	Use	Depth (feet)
3-2301-15	W248-E	Waipahu	Irrigation	500.00
3-2301-16	W248-F	Waipahu	Irrigation	500.00
3-2301-17	W248-G	Waipahu	Irrigation	500.00
3-2301-18	W248-H	Waipahu	Irrigation	500.00
3-2301-19	W248-I	Waipahu	Irrigation	500.00
3-2301-20	W248-J	Waipahu	Irrigation	500.00
3-2301-21	W249-A	Waipahu	Irrigation	425.00
3-2301-22	W249-B	Waipahu	Irrigation	425.00
3-2301-23	W249-C	Waipahu	Irrigation	400.00
3-2301-24	W249-D	Waipahu	Irrigation	410.00
3-2301-25	W249-E	Waipahu	Irrigation	--
3-2301-26	W249-F	Waipahu	Irrigation	410.00
3-2301-27	W249-G	Waipahu	Irrigation	400.00
3-2301-28	W249-H	Waipahu	Irrigation	400.00
3-2301-29	W249-I	Waipahu	Irrigation	410.00
3-2301-30	W249-J	Waipahu	Irrigation	420.00
3-2301-31	W249-K	Waipahu	Irrigation	429.00
3-2301-32	W249-L	Waipahu	Irrigation	439.00
3-2301-34	W256-3A	Schof. Brks.	Public Supply	194.00
3-2301-35	W256-3B	Schof. Brks.	Public Supply	197.00
3-2301-36	W256-3C	Schof. Brks.	Public Supply	198.00
3-2301-37	W256-3D	Schof. Brks.	Public Supply	195.00
3-2301-38	HOAEAE	Schof. Brks.	Public Supply	276.00
3-2301-39	HOAEAE	Schof. Brks.	Public Supply	273.00
3-2302-01	W256-2A	Schof. Brks.	Public Supply	350.00
3-2302-02	W256-2B	Schof. Brks.	Public Supply	338.00
3-2302-03	Kunia 1-3	Schof. Brks.	Public Supply	246.00
3-2302-04	Kunia 1-4	Schof. Brks.	Public Supply	391.00
3-2354-01	S12	Waipahu	Public Supply	183.00
3-2355-03	W189-1A	Waipahu	Public Supply	342.00

TABLE D.6 (Continued)
MUNICIPAL AND HIGH-CAPACITY WATER WELLS
IN USE NEAR POL PIPELINE AND POL FACILITIES

Local No.	Old No.	Name	Use	Depth (feet)
3-2355-05	W189-1C	Waipahu	Public Supply	340.00
3-2355-06	W189-2A	Waipahu	Public Supply	360.00
3-2355-07	W189-2B	Waipahu	Public Supply	358.00
3-2355-09	W191-1A	Waipahu	Public Supply	413.00
3-2355-10	W191-1B	Waipahu	Public Supply	413.00
3-2355-11	W191-1C	Waipahu	Public Supply	413.00
3-2355-12	W191-1D	Waipahu	Public Supply	413.00
3-2355-13	W191-1E	Waipahu	Public Supply	413.00
3-2355-14	W191-1F	Waipahu	Public Supply	413.00
3-2356-19	W196-F	Waipahu	Irrigation	550.00
3-2356-20	W196-G	Waipahu	Irrigation	550.00
3-2356-21	W196-H	Waipahu	Irrigation	550.00
3-2356-22	W196-I	Waipahu	Irrigation	550.00
3-2356-23	W196-J	Waipahu	Irrigation	550.00
3-2356-24	W196-K	Waipahu	Irrigation	550.00
3-2356-25	W196-L	Waipahu	Irrigation	550.00
3-2356-26	W196-M	Waipahu	Irrigation	550.00
3-2356-27	W196-N	Waipahu	Irrigation	550.00
3-2356-28	W196-O	Waipahu	Irrigation	550.00
3-2356-29	W196-P	Waipahu	Irrigation	550.00
3-2356-30	W196-Q	Waipahu	Irrigation	550.00
3-2356-31	W196-R	Waipahu	Irrigation	550.00
3-2356-32	W196-S	Waipahu	Irrigation	550.00
3-2356-33	W196-T	Waipahu	Irrigation	550.00
3-2356-34	W197-A	Waipahu	Irrigation	955.00
3-2356-36	W197-C	Waipahu	Irrigation	--
3-2356-37	W197-D	Waipahu	Irrigation	707.00
3-2356-38	W197-E	Waipahu	Irrigation	405.00
3-2356-39	W197-F	Waipahu	Irrigation	503.00
3-2356-40	W197-G	Waipahu	Irrigation	510.00

TABLE D.6 (Continued)
MUNICIPAL AND HIGH-CAPACITY WATER WELLS
IN USE NEAR POL PIPELINE AND POL FACILITIES

Local No.	Old No.	Name	Use	Depth (feet)
3-2356-41	W197-H	Waipahu	Irrigation	504.00
3-2356-42	W197-J	Waipahu	Irrigation	484.00
3-2356-49	W195-1A	Waipahu	Public Supply	327.00
3-2356-50	W195-1B	Waipahu	Public Supply	327.00
3-2356-54	W191-2	Waipahu	Irrigation	552.00
3-2356-55	W191-3A	Waipahu	Public Supply	289.00
3-2356-56	W191-3B	Waipahu	Public Supply	549.00
3-2356-58	AIEA	Waipahu	Public Supply	341.00
3-2356-59	--	Waipahu	Public Supply	345.00
3-2356-60	Waimalu II	Waipahu	Public Supply	240.00
3-2356-61	Kaonohi II	Waipahu	Public Supply	194.00
3-2356-62	Kaonohi II	Waipahu	Public Supply	--
3-2356-63	Waimalu II	Waipahu	Public Supply	--
3-2356-64	Waimalu II	Waipahu	Public Supply	240.00
3-2356-65	Kaonohi II	Waipahu	Public Supply	--
3-2357-07	W198-1	Waipahu	Domestic	[illegible].00
3-2357-08	W198-2	Waipahu	Domestic	72.00
3-2357-13	S8	Waipahu	Irrigation	96.00
3-2357-21	W198-3	Waipahu	Irrigation	167.00
3-2357-23	Waiau	Waipahu	Public Supply	230.00
3-2357-24	Waiau	Waipahu	Public Supply	266.00
3-2358-01	W200	Waipahu	Irrigation	91.00
3-2358-02	W201	Waipahu	Irrigation	336.00
3-2358-08	W204	Waipahu	Irrigation	59.00
3-2358-14	W203-A	Waipahu	Irrigation	175.00
3-2358-21	W204-3	Waipahu	Irrigation	120.00
3-2358-22	W204-4	Waipahu	Irrigation	76.00
3-2358-23	W204-5	Waipahu	Domestic	150.00
3-2358-24	W204-6	Waipahu	Domestic	120.00
3-2358-25	W204-7	Waipahu	Irrigation	150.00

TABLE D.6 (Continued)
MUNICIPAL AND HIGH-CAPACITY WATER WELLS
IN USE NEAR POL PIPELINE AND POL FACILITIES

Local No.	Old No.	Name	Use	Depth (feet)
3-2358-26	W204-8	Waipahu	Irrigation	150.00
3-2358-27	W200-1	Waipahu	Irrigation	100.00
3-2358-29	W204-9	Waipahu	Irrigation	50.00
3-2358-30	W204-16	Waipahu	Domestic	103.00
3-2358-32	W204-18	Waipahu	Irrigation	78.50
3-2358-33	W204-19	Waipahu	Irrigation	136.00
3-2358-34	W204-20	Waipahu	Irrigation	156.00
3-2358-35	W204-21	Waipahu	Domestic	102.00
3-2358-36	W204-22	Waipahu	Domestic	102.00
3-2358-37	W200-3	Waipahu	Irrigation	98.00
3-2358-38	W204-27	Waipahu	Domestic	100.00
3-2358-40	W204-30	Waipahu	Domestic	119.00
3-2358-41	W204-31	Waipahu	Irrigation	90.30
3-2358-42	W204-35	Waipahu	Irrigation	110.00
3-2358-43	W204-36	Waipahu	Domestic	30.00
3-2358-44	W204-38	Waipahu	Irrigation	165.00
3-2358-45	W204-40	Waipahu	Domestic	101.00
3-2358-46	W204-41	Waipahu	Domestic	175.00
3-2358-47	W204-43	Waipahu	Domestic	141.00
3-2358-48	W201-1	Waipahu	Irrigation	195.00
3-2358-49	Pearl	Waipahu	Domestic	125.00
3-2359-04	W204-10	Waipahu	Irrigation	105.00
3-2359-05	W204-11	Waipahu	Irrigation	57.00
3-2359-06	W204-12	Waipahu	Irrigation	131.00
3-2359-07	W204-13	Waipahu	Domestic	140.00
3-2359-08	W204-14	Waipahu	Irrigation	96.00
3-2359-09	W204-15	Waipahu	Domestic	102.00
3-2359-10	W204-23	Waipahu	Domestic	100.00
3-2359-11	W204-24	Waipahu	Domestic	130.00
3-2359-12	W235-1	Waipahu	Domestic	276.00

TABLE D.6 (Continued)
MUNICIPAL AND HIGH-CAPACITY WATER WELLS
IN USE NEAR POL PIPELINE AND POL FACILITIES

Local No.	Old No.	Name	Use	Depth (feet)
3-2359-13	W204-25	Waipahu	Domestic	130.00
3-2359-14	W204-28	Waipahu	Irrigation	171.00
3-2359-15	W204-32	Waipahu	Irrigation	191.00
3-2359-16	W204-33	Waipahu	Irrigation	162.00
3-2359-17	W204-34	Waipahu	Irrigation	175.00
3-2359-18	W204-37	Waipahu	Irrigation	126.00
3-2400-01	W241-1A	Waipahu	Public Supply	355.00
3-2400-02	W241-1B	Waipahu	Public Supply	355.00
3-2400-03	W241-1C	Waipahu	Public Supply	386.00
3-2400-04	W241-1D	Waipahu	Public Supply	386.00
3-2402-01	W256-4A	Schof. Brks.	Public Supply	575.00
3-2402-02	W256-4B	Schof. Brks.	Public Supply	575.00
3-2456-01	Newtown 1	Waipahu	Public Supply	307.00
3-2456-02	Newtown 2	Waipahu	Public Supply	301.00
3-2456-03	Newtown 3	Waipahu	Public Supply	307.00
3-2457-01	W202-2A	Waipahu	Public Supply	398.00
3-2457-02	W202-2B	Waipahu	Public Supply	415.00
3-2457-03	W202-2C	Waipahu	Public Supply	425.00
3-2457-05	W196-2F	Waipahu	Public Supply	444.00
3-2457-06	W196-2A	Waipahu	Public Supply	458.00
3-2457-09	W196-2B	Waipahu	Public Supply	461.00
3-2457-10	W196-2D	Waipahu	Public Supply	368.00
3-2457-11	W196-2H	Waipahu	Public Supply	363.00
3-2457-12	W196-2G	Waipahu	Public Supply	367.00
3-2457-13	W196-3B	Waipahu	Public Supply	504.00
3-2457-14	W196-3A	Waipahu	Public Supply	504.00
3-2457-15	W196-3C	Waipahu	Public Supply	504.00
3-2458-01	S9	Waipahu	Public Supply	102.00
3-2458-02	W202-1A	Waipahu	Public Supply	150.00
3-2458-03	W202-1B	Waipahu	Public Supply	140.00

TABLE D.6 (Continued)
MUNICIPAL AND HIGH-CAPACITY WATER WELLS
IN USE NEAR POL PIPELINE AND POL FACILITIES

Local No.	Old No.	Name	Use	Depth (feet)
3-2459-01	W239-A	Waipahu	Irrigation	704.00
3-2459-02	W239-B	Waipahu	Irrigation	582.00
3-2459-03	W239-C	Waipahu	Irrigation	739.00
3-2459-04	W239-D	Waipahu	Irrigation	706.00
3-2459-05	W239-E	Waipahu	Irrigation	600.00
3-2459-06	W239-F	Waipahu	Irrigation	700.00
3-2459-07	W239-G	Waipahu	Irrigation	590.00
3-2459-08	W239-H	Waipahu	Irrigation	577.00
3-2459-09	W239-I	Waipahu	Irrigation	707.00
3-2459-10	W239-J	Waipahu	Irrigation	700.00
3-2459-11	W239-K	Waipahu	Irrigation	--
3-2459-12	W239-L	Waipahu	Irrigation	--
3-2459-13	W239-M	Waipahu	Irrigation	700.00
3-2459-14	W239-N	Waipahu	Irrigation	700.00
3-2459-17	W204-29	Waipahu	Domestic	142.00
3-2459-18	W204-39	Waipahu	Domestic	185.00
3-2459-19	W241-2A	Waipahu	Public Supply	337.00
3-2459-20	W241-2B	Waipahu	Public Supply	337.00
3-2459-21	W239-2	Waipahu	Irrigation	456.00
3-2459-22	--	Waipahu	Public Supply	114.00
3-2459-23	WAIPIOHTS3	Waipahu	Public Supply	363.00
3-2459-24	WAIPIOHTS4	Waipahu	Public Supply	367.00
3-2459-25	--	Waipahu	Domestic	100.00
3-2500-01	WAIPIO 1	Waipahu	Public Supply	546.00
3-2500-02	WAIPIO 2	Waipahu	Public Supply	560.00
3-2558-10	S16	Waipahu	Public Supply	170.00
3-2600-02	W251-2	Waipahu	Public Supply	401.00
3-2600-03	MILIL III 1	Waipahu	Public Supply	850.00
3-2600-04	MILIL III 2	Waipahu	Public Supply	850.00
3-2603-01	W330-8	Schof. Brks.	Public Supply	991.00

TABLE D.6 (Continued)
MUNICIPAL AND HIGH-CAPACITY WATER WELLS
IN USE NEAR POL PIPELINE AND POL FACILITIES

Local No.	Old No.	Name	Use	Depth (feet)
3-2658-01	W250-3A	Waipahu	Irrigation	805.00
3-2658-02	W250-3B	Waipahu	Irrigation	835.00
3-2658-03	--	Waipahu	Irrigation	--
3-2800-01	W250-4A	Waipahu	Public Supply	1012.00
3-2800-02	W250-4B	Waipahu	Public Supply	1008.00
3-2800-03	MILIL TN 3	Waipahu	Public Supply	1022.00
3-2800-04	MILIL TN 4	Waipahu	Public Supply	1008.00
3-2803-05	W330-7C	Schof. Brks.	Public Supply	1020.00
3-2803-07	KUNIA	Schof. Brks.	Irrigation	990.00
3-2859-01	MILIL II 1	Waipahu	Public Supply	995.00
3-2859-02	MILIL II 2	Waipahu	Public Supply	985.00
3-2901-01	W330-A	Schof. Brks.	Public Supply	80.00
3-2901-02	W330-B	Schof. Brks.	Public Supply	27.50
3-2901-03	W330-C	Schof. Brks.	Public Supply	150.00
3-2901-04	W330-D	Schof. Brks.	Public Supply	203.00
3-2901-05	T17	Schof. Brks.	Public Supply	300.00
3-2901-06	W330-E	Schof. Brks.	Public Supply	264.00
3-2901-07	S4	Schof. Brks.	Public Supply	566.00
3-2901-08	W330-3	Schof. Brks.	Public Supply	880.00
3-2901-09	W330-6	Schof. Brks.	Public Supply	990.00
3-2901-10	W330-F	Schof. Brks.	Public Supply	287.00
3-2901-11	W330-9	Schof. Brks.	Public Supply	821.00
3-2904-01	W330-4	Schof. Brks.	Public Supply	170.00

APPENDIX E

MASTER LIST OF SHOPS

APPENDIX E

MASTER LIST OF SHOPS

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Typical TSD Methods
<u>BELLOWS AFS</u>				
1957th Communications Group, OL-A	700,701,703	Yes	Yes	Off Base
Detachment 1, 15th Air Base Wing				
CE Shop	538,544	Yes	Yes	Off Base
Motor Pool	540	Yes	Yes	Off Base
Hawaii Army National Guard, 291st Maintenance Co.	804,806,808	Yes	Yes	Off Base
<u>KAENA PT. STS</u>				
Generator and Maintenance Bldg.	39 & 35	Yes	Yes	Off Base
Antenna & Admin.	41	Yes	Yes	Off Base
Antenna & Admin.	10,13 & 19	Yes	Yes	Off Base
<u>PUNAMANO AFS</u>				
Generator Building	T-78	Yes	Yes	Off Base
Administration Bldg.	T-84	No	No	-
<u>KOKEE AFS</u>				
Vehicle Maintenance	10	Yes	Yes	Off Base
Antenna & Other Bldgs.	1 & 5	Yes	Yes	Off Base
Generator Building	2	Yes	Yes	Off Base

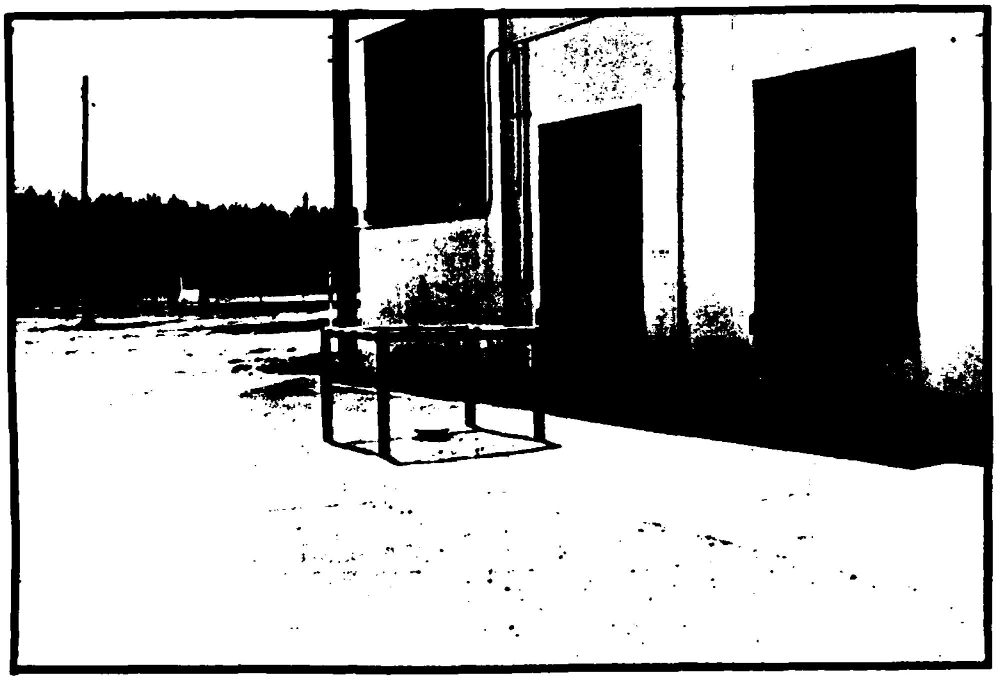
APPENDIX F

PHOTOGRAPHS

BELLOWS AFS

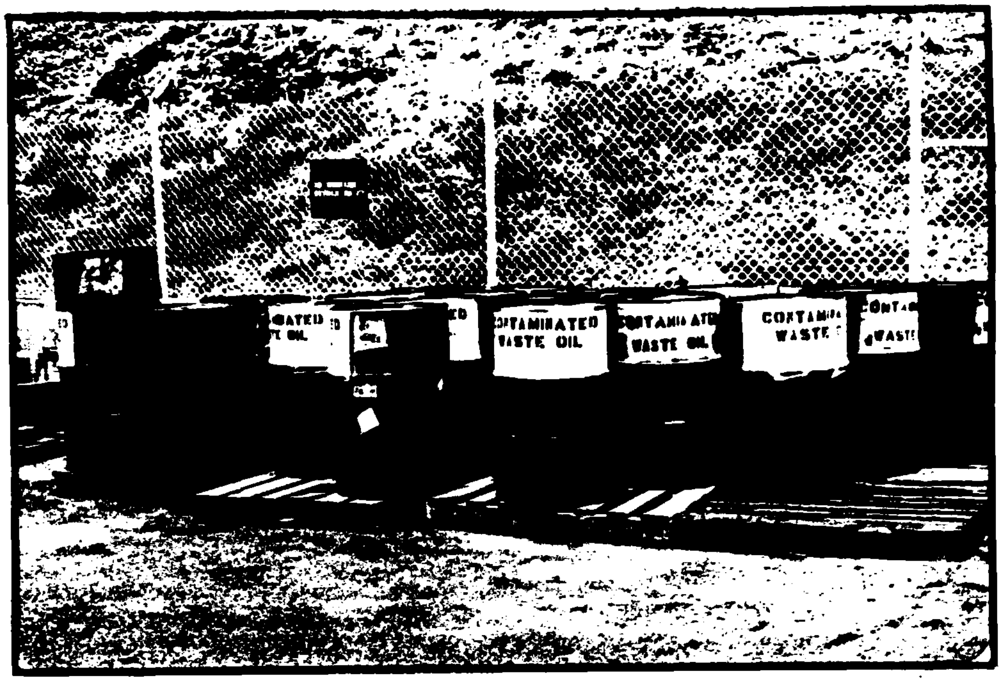
Landfill
FACING NORTH

BELLOWS AFS



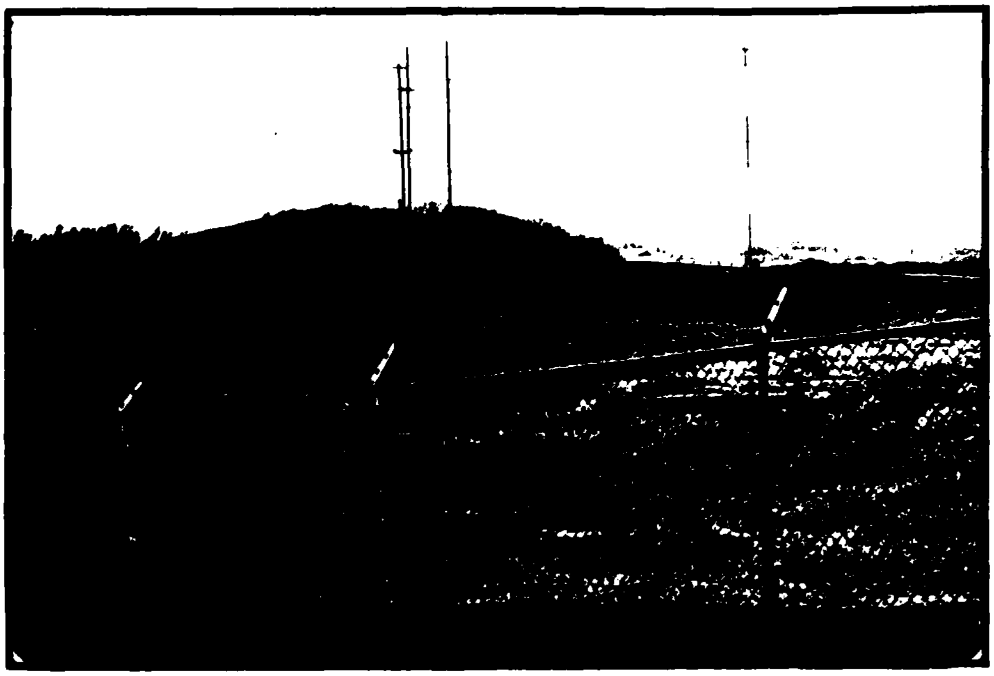
Waste Oil Tank
FACING EAST

KAENA PT. STS



Waste Oil Accumulation Area
FACING SOUTHWEST

PUNAMANO AFS

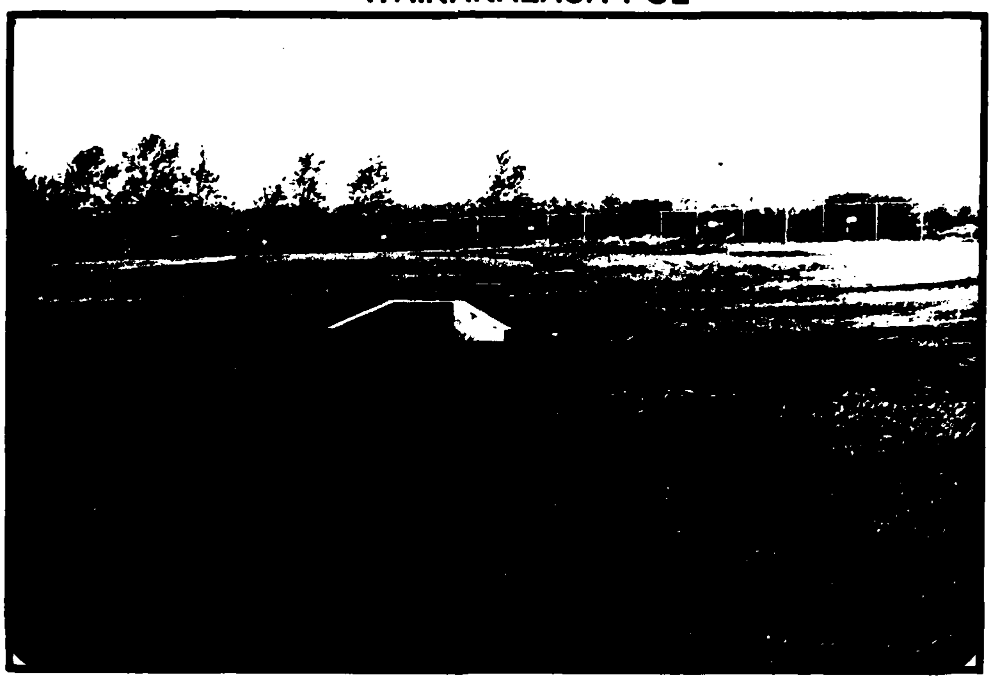


Near Motor Pool
FACING SOUTHWEST

WAIKAKALAUA POL

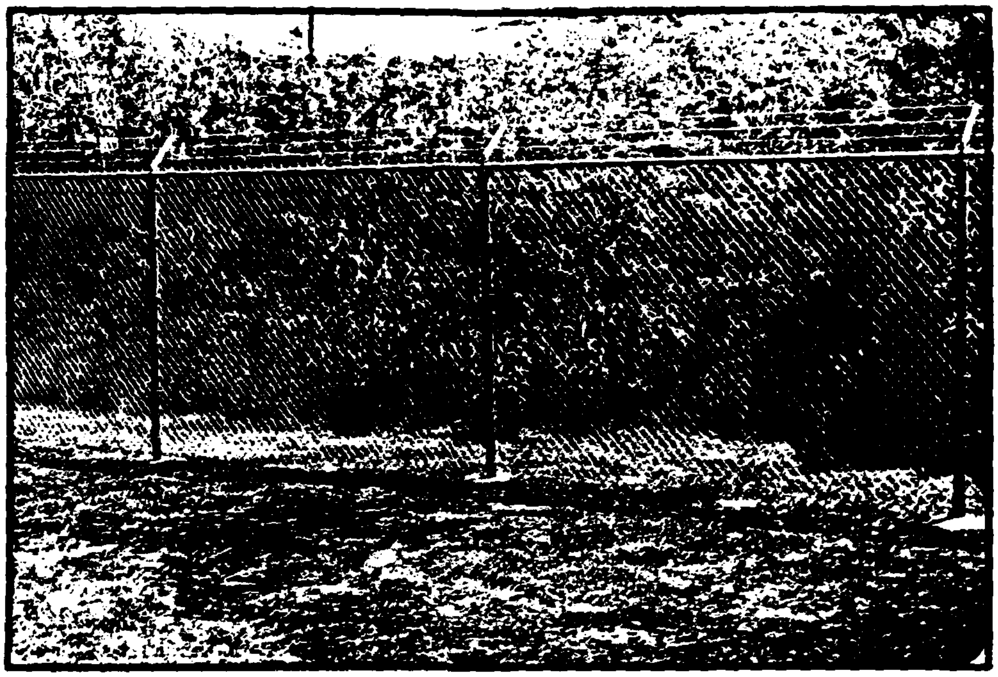
Storage Area
FACING NORTH

WAIKAKALAUA POL



Storage Area
FACING SOUTH

KIPAPA POL

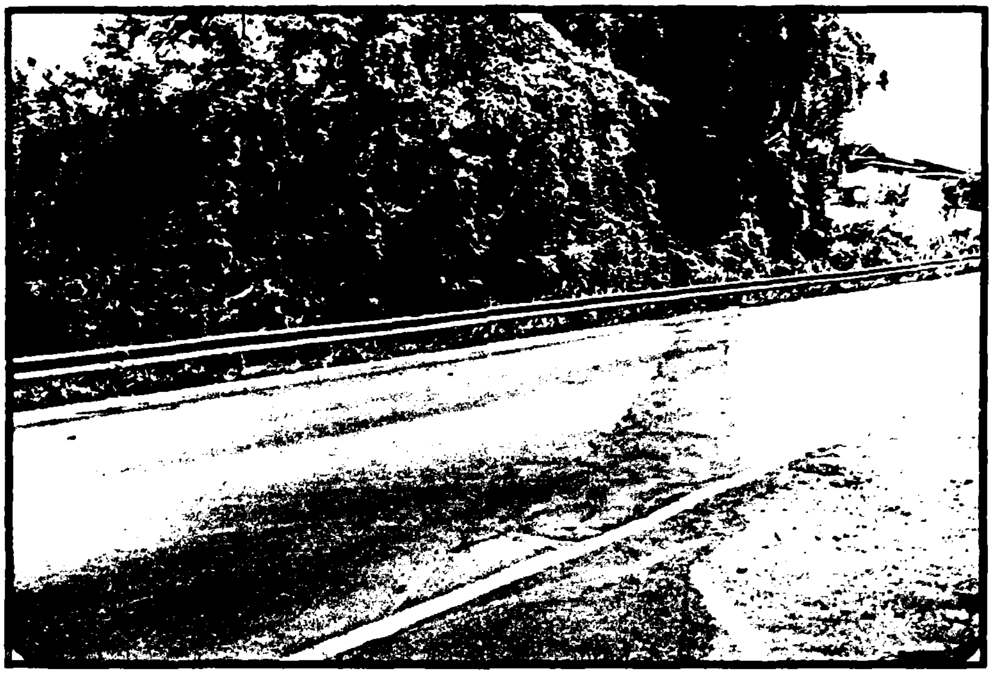


Tank Sludge Disposal Area
FACING EAST

WAIKAKALAUA POL

Tank Sludge Disposal Area
FACING NORTH

POL PIPELINE



Pipeline Leak No. 10 at Kamehameha Highway
FACING NORTH

KOKEE AFS

Waste Oil Accumulation Area
FACING SOUTH

APPENDIX G

USAF INSTALLATION RESTORATION PROGRAM

HAZARD ASSESSMENT RATING METHODOLOGY

APPENDIX G

USAF INSTALLATION RESTORATION PROGRAM
HAZARD ASSESSMENT RATING METHODOLOGY

BACKGROUND

The Department of Defense (DOD) has established a comprehensive program to identify, evaluate, and control problems associated with past disposal practices at DOD facilities. One of the actions required under this program is to:

> "develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts." (Reference: DEQPPM 81-5, 11 December 1981).

Accordingly, the United States Air Force (USAF) has sought to establish a system to set priorities for taking further actions at sites based upon information gathered during the Records Search phase of its Installation Restoration Program (IRP).

The first site rating model was developed in June 1981 at a meeting with represenatives from USAF Occupational and Environmental Health Laboratory (OEHL), Air Force Engineering and Services Center (AFESC), Engineering-Science (ES) and CH2M Hill. The basis for this model was a system developed for EPA by JRB Associates of McLean, Virginia. The JRB model was modified to meet Air Force needs.

After using this model for 6 months at over 20 Air Force installations, certain inadequacies became apparent. Therefore, on January 26 and 27, 1982, representatives of USAF OEHL, AFESC, various major commands, Engineering-Science, and CH2M Hill met to address the inadequacies. The result of the meeting was a new site rating model designed to present a better picture of the hazards posed by sites at Air Force installations. The new rating model described in this presentation is referred to as the Hazard Assessment Rating Methodology.

PURPOSE

The purpose of the site rating model is to provide a relative ranking of sites of suspected contamination from hazardous substances. This model will assist the Air Force in setting priorities for follow-on site investigations and confirmation work under Phase II of the IRP.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous wastes present in sufficient quantity), and (2) potential for migration exists. A site can be deleted from consideration for rating on either basis.

DESCRIPTION OF MODEL

Like the other hazardous waste site ranking models, the U.S. Air Force's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DOD program needs.

The model uses data readily obtained during the Records Search portion (Phase I) of the IRP. Scoring judgments and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and the worst hazards at the site. Sites are given low scores only if there are clearly no hazards at the site. This approach meshes well with the policy for evaluating and setting restrictions on excess DOD properties.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: the possible receptors of the contamination, the waste and its characteristics, potential pathways for waste contaminant migration, and any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating.

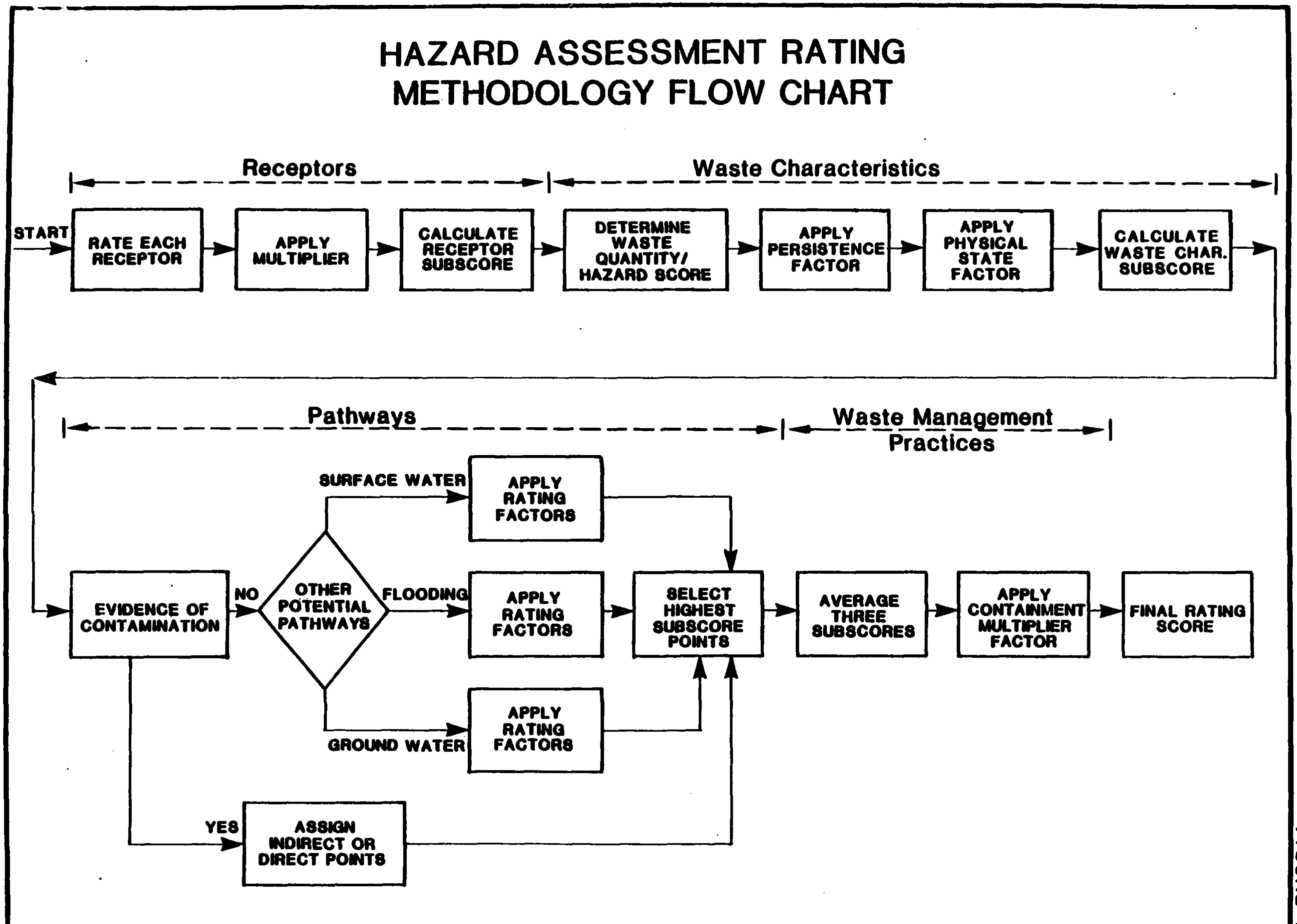
The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant and adding the weighted scores to obtain a total category score.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned and for direct evidence, 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface water migration, flooding, and ground-water migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Sites at which there is no containment are not reduced in score. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the scores for the other three categories.

FIGURE 1



HAZARD ASSESSMENT RATING
METHODOLOGY FLOW CHART
Receptors
Waste Characteristics
START
RATE EACH RECEPTOR
APPLY MULTIPLIER
CALCULATE RECEPTOR SUBSCORE
DETERMINE WASTE QUANTITY/ HAZARD SCORE
APPLY PERSISTENCE FACTOR
APPLY PHYSICAL STATE FACTOR
CALCULATE WASTE CHAR. SUBSCORE
Pathways
Waste Management Practices
EVIDENCE OF CONTAMINATION
NO
YES
OTHER POTENTIAL PATHWAYS
SURFACE WATER
FLOODING
GROUND WATER
APPLY RATING FACTORS
APPLY RATING FACTORS
APPLY RATING FACTORS
ASSIGN INDIRECT OR DIRECT POINTS
SELECT HIGHEST SUBSCORE POINTS
AVERAGE THREE SUBSCORES
APPLY CONTAINMENT MULTIPLIER FACTOR
FINAL RATING SCORE

FIGURE 2

HAZARD ASSESSMENT RATING METHODOLOGY FORM

NAME OF SITE ______

LOCATION ______

DATE OF OPERATION OR OCCURRENCE ______

OWNER/OPERATOR ______

COMMENTS/DESCRIPTION ______

SITE RATED BY ______

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site		4		
B. Distance to nearest well		10		
C. Land use/zoning within 1 mile radius		3		
D. Distance to reservation boundary		6		
E. Critical environments within 1 mile radius of site		10		
F. Water quality of nearest surface water body		6		
G. Ground water use of uppermost aquifer		9		
H. Population served by surface water supply within 3 miles downstream of site		6		
I. Population served by ground-water supply within 3 miles of site		6		
		Subtotals	______	______

Receptors subscore (100 X factor score subtotal/maximum score subtotal) ______

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) ______
2. Confidence level (C = confirmed, S = suspected) ______
3. Hazard rating (H = high, M = medium, L = low) ______

Factor Subscore A (from 20 to 100 based on factor score matrix) ______

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

______ X ______ = ______

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

______ X ______ = ______

FIGURE 2 (Continued)

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore ______

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water		8		
Net precipitation		6		
Surface erosion		8		
Surface permeability		6		
Rainfall intensity		8		

Subtotals ______ ______

Subscore (100 X factor score subtotal/maximum score subtotal) ______

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
2. Flooding		1		

Subscore (100 x factor score/3) ______

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water		8		
Net precipitation		6		
Soil permeability		8		
Subsurface flows		8		
Direct access to ground water		8		

Subtotals ______ ______

Subscore (100 x factor score subtotal/maximum score subtotal) ______

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore ______

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors ______
Waste Characteristics ______
Pathways ______

Total ______ divided by 3 = ______
Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

______ X ______ = ☐

TABLE 1

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

I. RECEPTORS CATEGORY

Rating Factors	Rating Scale Levels 0	1	2	3	Multiplier
A. Population within 1,000 feet (includes on-base facilities)	0	1 - 25	26 - 100	Greater than 100	4
B. Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet	10
C. Land Use/Zoning (within 1 mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or industrial	Residential	3
D. Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet	6
E. Critical environments (within 1 mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination.	Major habitat of an endangered or threatened species; presence of recharge area; major wetlands.	10
F. Water quality/use designation of nearest surface water body	Agricultural or industrial use.	Recreation, propagation and management of fish and wildlife.	Shellfish propagation and harvesting.	Potable water supplies	6
G. Ground-Water use of uppermost aquifer	Not used, other sources readily available.	Commercial, industrial, or irrigation, very limited other water sources.	Drinking water, municipal water available.	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available.	9
H. Population served by surface water supplies within 3 miles downstream of site	0	1 - 50	51 - 1,000	Greater than 1,000	6
I. Population served by aquifer supplies within 3 miles of site	0	1 - 50	51 - 1,000	Greater than 1, 000	6

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

S = Small quantity (<5 tons or 20 drums of liquid)
M = Moderate quantity (5 to 20 tons or 21 to 85 drums of liquid)
L = Large quantity (>20 tons or 85 drums of liquid)

A-2 Confidence Level of Information

C = Confirmed confidence level (minimum criteria below)

- o Verbal reports from interviewer (at least 2) or written information from the records.
- o Knowledge of types and quantities of wastes generated by shops and other areas on base.
- o Based on the above, a determination of the types and quantities of waste disposed of at the site.

S = Suspected confidence level

- o No verbal reports or conflicting verbal reports and no written information from the records.
- o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site.

A-3 Hazard Rating

Hazard Category	Rating Scale Levels 0	1	2	3
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2	Sax's Level 3
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F	Flash point less than 80°F
Radioactivity	At or below background levels	1 to 3 times background levels	3 to 5 times background levels	Over 5 times background levels

Use the highest individual rating based on toxicity, ignitability and radioactivity and determine the hazard rating.

Hazard Rating	Points
High (H)	3
Medium (M)	2
Low (L)	1

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS (Continued)

Waste Characteristics Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
80	L	C	M
	M	C	H
70	L	S	H
60	S	C	H
	M	C	M
50	L	S	M
	L	C	L
	M	S	H
	S	C	M
40	S	S	H
	M	S	M
	M	C	L
	L	S	L
30	S	C	L
	M	S	L
	S	S	M
20	S	S	L

Notes:
For a site with more than one hazardous waste, the waste quantities may be added using the following rules:
Confidence Level
- o Confirmed confidence levels (C) can be added
- o Suspected confidence levels (S) can be added
- o Confirmed confidence levels cannot be added with suspected confidence levels

Waste Hazard Rating
- o Wastes with the same hazard rating can be added
- o Wastes with different hazard ratings can only be added in a downgrade mode, e.g., MCM + SCH = LCM if the total quantity is greater than 20 tons.

Example: Several wastes may be present at a site, each having an MCM designation (60 points). By adding the quantities of each waste, the designation may change to LCM (80 points). In this case, the correct point rating for the waste is 80.

B. Persistence Multiplier for Point Rating

Persistence Criteria	Multiply Point Rating From Part A by the Following
Metals, polycyclic compounds, and halogenated hydrocarbons	1.0
Substituted and other ring compounds	0.9
Straight chain hydrocarbons	0.8
Easily biodegradable compounds	0.4

C. Physical State Multiplier

Physical State	Multiply Point Total From Parts A and B by the Following
Liquid	1.0
Sludge	0.75
Solid	0.50

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, ground water, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 POTENTIAL FOR SURFACE WATER CONTAMINATION

Rating Factor	Rating Scale Levels 0	1	2	3	Multiplier
Distance to nearest surface water (includes drainage ditches and storm sewers)	Greater than 1 mile	2,001 feet to 1 mile	501 feet to 2,000 feet	0 to 500 feet	8
Net precipitation	Less than -10 in.	-10 to + 5 in.	+5 to +20 in.	Greater than +20 in.	6
Surface erosion	None	Slight	Moderate	Severe	8
Surface permeability	0% to 15% clay ($>10^{-2}$ cm/sec)	15% to 30% clay (10^{-2} to 10^{-4} cm/sec)	30% to 50% clay (10^{-4} to 10^{-6} cm/sec)	Greater than 50% clay ($<10^{-6}$ cm/sec)	6
Rainfall intensity based on 1 year 24-hr rainfall	<1.0 inch	1.0-2.0 inches	2.1-3.0 inches	>3.0 inches	8

B-2 POTENTIAL FOR FLOODING

Rating Factor	0	1	2	3	Multiplier
Floodplain	Beyond 100-year floodplain	In 25-year flood-plain	In 10-year flood-plain	Floods annually	1

B-3 POTENTIAL FOR GROUND-WATER CONTAMINATION

Rating Factor	0	1	2	3	Multiplier
Depth to ground water	Greater than 500 ft	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.	6
Soil permeability	Greater than 50% clay ($>10^{-6}$ cm/sec)	30% to 50% clay (10^{-4} to 10^{-6} cm/sec)	15% to 30% clay (10^{-2} to 10^{-4} cm/sec)	0% to 15% clay ($<10^{-2}$ cm/sec)	8
Subsurface flows	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean ground-water level	8
Direct access to ground water (through faults, fractures, faulty well casings, subsidence fissures, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	8

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

IV. **WASTE MANAGEMENT PRACTICES CATEGORY**

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subscores.

B. **WASTE MANAGEMENT PRACTICES FACTOR**

The following multipliers are then applied to the total risk points (from A):

Waste Management Practice	Multiplier
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Fire Proection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1 or III-B-3, then leave blank for calculation of factor score and maximum possible score.

APPENDIX H

SITE HAZARD ASSESSMENT RATING FORMS

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Landfill
Location: Bellows AFS
Date of Operation or Occurrence: 1940's to 1970's; hazardous wastes 1943-46
Owner/Operator: Bellows AFS
Comments/Description: Assume some hazardous wastes from shops 1943-1946 disposed

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	0	6	0	18
Subtotals			86	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 48

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) m
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 80

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

80 x 0.80 = 64

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

64 x 1.00 = 64

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			74	108
Subscore (100 x factor score subtotal/maximum score subtotal)				69
2. Flooding	1	1	1	3
Subscore (100 x factor score/3)				33
3. Ground-water migration				
Depth to ground water	2	8	16	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			44	114
Subscore (100 x factor score subtotal/maximum score subtotal)				39

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 69

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 48
Waste Characteristics 64
Pathways 69
Total 181 divided by 3 = 60 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

60 x 1.00 = 60

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: WWII Shop Area/Septic Tank System
Location: Bellows AFS
Date of Operation or Occurrence: 1943 - 46
Owner/Operator: Bellows AFS
Comments/Description: Assume some hazardous wastes from shops disposed

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	0	6	0	18
Subtotals			92	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 51

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) s
2. Confidence level (1=confirmed, 2=suspected) s
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

40 x 0.80 = 32

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

32 x 1.00 = 32

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	1	8	8	24
Net precipitation	2	6	12	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			58	108
Subscore (100 x factor score subtotal/maximum score subtotal)				54
2. Flooding	1	1	1	3
Subscore (100 x factor score/3)				33
3. Ground-water migration				
Depth to ground water	2	8	16	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			44	114
Subscore (100 x factor score subtotal/maximum score subtotal)				39

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 54

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		51
Waste Characteristics		32
Pathways		54
Total	137	divided by 3 = 46 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

46 x 1.00 = 46

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Power Plant - Tank Leak and Rinsewater Disposal
Location: Kaena Pt. Station
Date of Operation or Occurrence: 1972 (leak); 1965 - Present (Rinsewater)
Owner/Operator: Kaena Pt. Station
Comments/Description: Diesel fuel leak (1800 gal); Oily rinsewater

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	1	10	10	30
C. Land use/zoning within 1 mile radius	1	3	3	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	1	6	6	18
Subtotals			75	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 42

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) m
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 80

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

80 x 0.80 = 64

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

64 x 1.00 = 64

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	2	6	12	18
Surface erosion	1	8	8	24
Surface permeability	0	6	0	18
Rainfall intensity	3	8	24	24
Subtotals			60	108
Subscore (100 x factor score subtotal/maximum score subtotal)				56
2. Flooding	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	0	8	0	24
Net precipitation	2	6	12	18
Soil permeability	3	8	24	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			36	114
Subscore (100 x factor score subtotal/maximum score subtotal)				32

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 56

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		42
Waste Characteristics		64
Pathways		56
Total	162	divided by 3 = 54 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

54 x 1.00 = 54

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Entire Site - Sludge and Fuel Disposal
Location: Waikakalaua POL Storage Area
Date of Operation or Occurrence: 1950 - 1975 (Sludge); 1943 - Present (Fuel)
Owner/Operator: Hickan AFB
Comments/Description: Residual tank cleaning sludges; AVGAS, MOGAS, JP-4 fuel

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			129	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 72

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) I
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			72	108
Subscore (100 x factor score subtotal/maximum score subtotal)				67
2. Flooding	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	0	8	0	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			34	114
Subscore (100 x factor score subtotal/maximum score subtotal)				30

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 67

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		72	
Waste Characteristics		80	
Pathways		67	
Total	219	divided by 3 =	73 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

73 x 1.00 = \ 73 \

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Sludge disposal and Pipe Fuel Leak Area
Location:Kipapa POL Storage Area
Date of Operation or Occurrence: 1950 - 1976 (Sludge); 1975 (Leak)
Owner/Operator: Hickman AFB
Comments/Description: Residual tank cleaning sludges; AVGAS fuel

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			129	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 72

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	2	1	2	3
Subscore (100 x factor score/3)				67
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			42	114
Subscore (100 x factor score subtotal/maximum score subtotal)				37

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	72	
Waste Characteristics	80	
Pathways	74	
Total	226 divided by 3 =	75 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

75 x 1.00 = 75

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 7
Location: In media of Kamehameha Hwy. one mile west of Aiea Junction near Waimulu Stream (Coastal Area)
Date of Operation or Occurrence: 1954
Owner/Operator: Hickam AFB
Comments/Description: 20,000 gal. AVGAS (on line now abandoned)

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			131	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 73

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	2	1	2	3
Subscore (100 x factor score/3)				67
3. Ground-water migration				
Depth to ground water	2	8	16	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			50	114
Subscore (100 x factor score subtotal/maximum score subtotal)				44

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		73	
Waste Characteristics		80	
Pathways		74	
Total	227	divided by 3 =	76 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

76 x 1.00 = 76

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 10
Location: POL Pipeline - At Kamehameha Hwy. Crossing near Kipapa (Upland Area)
Date of Operation or Occurrence: 1978
Owner/Operator: Hickam AFB
Comments/Description: 50,000 gal. JP-4

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			133	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 74

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore　0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	0	8	0	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			34	114
Subscore (100 x factor score subtotal/maximum score subtotal)				30

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore　74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	74		
Waste Characteristics	80		
Pathways	74		
Total 228	divided by 3 =	76	Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

76　x　1.00　=　\ 76 \

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 5
Location: Kipapa Stream bed of the Kipapa Gulch (Upland Area)
Date of Operation or Occurrence: 1954
Owner/Operator: Hickam AFB
Comments/Description: 20,000 gal. AVGAS

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			129	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 72

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	NA	1	NA	NA
Subscore (100 x factor score/3)				NA
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			42	114
Subscore (100 x factor score subtotal/maximum score subtotal)				37

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		72
Waste Characteristics		80
Pathways		74
Total	226	divided by 3 = 75 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

75 x 1.00 = 75

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 9
Location: POL Pipeline - Kipapa Valve Pit (Upland Area)
Date of Operation or Occurrence: 1957 - 1958
Owner/Operator: Hickam AFB
Comments/Description: 15,000 gal. AVGAS

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			129	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 72

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	2	1	2	3
Subscore (100 x factor score/3)				67
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			42	114
Subscore (100 x factor score subtotal/maximum score subtotal)				37

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		72
Waste Characteristics		80
Pathways		74
Total	226	divided by 3 = 75 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

75 x 1.00 = 75

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 1
Location: POL Pipeline - Vicinity of Waiwa Booster Station (Coastal Area)
Date of Operation or Occurrence: 1951
Owner/Operator: Hickam AFB
Comments/Description: 10,000 gal. AVGAS

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			121	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 67

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	1	1	1	3
Subscore (100 x factor score/3)				33
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			42	114
Subscore (100 x factor score subtotal/maximum score subtotal)				37

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		67
Waste Characteristics		80
Pathways		74
Total	221	divided by 3 = 74 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

74 x 1.00 = 74

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 3
Location: POL Pipeline - Line "B" near Mililani Ditch Crossing between Waikakalaua and old Kipapa Air Strip (Upland Are
Date of Operation or Occurrence: 1954
Owner/Operator: Hickam AFB
Comments/Description: 70,000 gal. AVGAS

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			123	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 68

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	2	1	2	3
Subscore (100 x factor score/3)				67
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			42	114
Subscore (100 x factor score subtotal/maximum score subtotal)				37

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	68
Waste Characteristics	80
Pathways	74
Total 222 divided by 3 =	74 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

74 x 1.00 = 74

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 8
Location: Near Ewa Junction (Coastal Area)
Date of Operation or Occurrence: 1955
Owner/Operator: Hickam AFB
Comments/Description: 15,000 gal. AVGAS

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			123	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 68

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	1	1	1	3
Subscore (100 x factor score/3)				33
3. Ground-water migration				
Depth to ground water	2	8	16	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			50	114
Subscore (100 x factor score subtotal/maximum score subtotal)				44

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		68
Waste Characteristics		80
Pathways		74
Total	222	divided by 3 = 74 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

74 x 1.00 = \ 74 \

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 4
Location: One mile north of Ewa Junction (Coastal Area)
Date of Operation or Occurrence: 1954
Owner/Operator: Hickam AFB
Comments/Description: 86,000 gal. AVGAS

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			127	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 71

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			72	108
Subscore (100 x factor score subtotal/maximum score subtotal)				67
2. Flooding	1	1	1	3
Subscore (100 x factor score/3)				33
3. Ground-water migration				
Depth to ground water	2	8	16	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			50	114
Subscore (100 x factor score subtotal/maximum score subtotal)				44

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 67

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		71	
Waste Characteristics		80	
Pathways		67	
Total	218	divided by 3 =	73 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

73 x 1.00 = 73

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 2
Location: North of Ewa Junction about 0.5 mile near Kamehameha Hwy. and Cane Haul Rd. (Coastal Area)
Date of Operation or Occurrence: 1954
Owner/Operator: Hickam AFB
Comments/Description: 300,000 gal. AVGAS

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			123	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 68

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			72	108
Subscore (100 x factor score subtotal/maximum score subtotal)				67
2. Flooding	1	1	1	3
Subscore (100 x factor score/3)				33
3. Ground-water migration				
Depth to ground water	2	8	16	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			50	114
Subscore (100 x factor score subtotal/maximum score subtotal)				44

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 67

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		68	
Waste Characteristics		80	
Pathways		67	
Total	215	divided by 3 =	72 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

72 x 1.00 = \ 72 \

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Leak No. 6
Location: Near Makalapa (Sub Base) Gate South of Halawa Stream (Coastal Area)
Date of Operation or Occurrence: 1954
Owner/Operator: Hickam AFB
Comments/Description: 22,000 gal. AVGAS (on line now abandoned)

Site Rated by: R. L. Thoem

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	1	10	10	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			111	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 62

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) c
3. Hazard rating (1=low, 2=medium, 3=high) h

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A x Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80 x 1.00 = 80

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	3	8	24	24
Subtotals			80	108
Subscore (100 x factor score subtotal/maximum score subtotal)				74
2. Flooding	1	1	1	3
Subscore (100 x factor score/3)				33
3. Ground-water migration				
Depth to ground water	2	8	16	24
Net precipitation	3	6	18	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			50	114
Subscore (100 x factor score subtotal/maximum score subtotal)				44

C. Highest pathway subscore.
Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 74

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors		62
Waste Characteristics		80
Pathways		74
Total	216	divided by 3 = 72 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score

72 x 1.00 = 72

APPENDIX I

GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

APPENDIX I

GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

aa: A type of lava flow having a rough, fragmental surface, consisting of clinkers and scoria.

ABG: Air Base Group

ABW: Air Base Wing

ACFT MAINT: Aircraft Maintenance.

AF: Air Force.

AFB: Air Force Base.

AFESC: Air Force Engineering and Services Center.

AFSCF: Air Force Satellite Control Facility.

AFFF: Aqueous Film Forming Foam, a fire extinquishing agent.

AFR: Air Force Regulation.

AFS: Air Force Station

Ag: Chemical symbol for silver.

AGE: Aerospace Ground Equipment.

Al: Chemical symbol for aluminum.

ALLUVIUM: Materials eroded, transported and deposited by streams.

ALLUVIAL FAN: A fan-shaped deposit formed by a stream either where it issues from a narrow mountain valley into a plain or broad valley, or where a tributary stream joins a main stream.

ANDESITE: A dark colored, fine-grained igneous rock frequently containing conspicuous crystals.

ANTICLINE: A fold in which layered strata are inclined down and away from the axes.

ARTESIAN: Ground water contained under hydrostatic pressure.

AQUICLUDE: Poorly permeable formation that impedes ground-water movement and does not yield to a well or spring.

AQUIFER: A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.

AQUITARD: A geologic unit which impedes ground-water flow.

AROMATIC: Description of organic chemical compounds in which the carbon atoms are arranged into a ring with special electron stability associated. Aromatic compounds are often more reactive than non-aromatics.

AVGAS: Aviation Gasoline.

Ba: Chemical symbol for barium.

BASALT: A dark commonly extrusive (or locally intrusive, as dikes), fine-grained igneous rock.

BES: Bioenvironmental Engineering Services.

BIOACCUMULATE: Tendency of elements or compounds to accumulate or build up in the tissues of living organisms when they are exposed to these elements in their environments, e.g., heavy metals.

BIODEGRADABLE: The characteristic of a substance to be broken down from complex to simple compounds by microorganisms.

BOWSER: A portable tank, usually under 200 gallons in capacity.

BX: Base Exchange.

$CaCO_3$: Chemical symbol for calcium carbonate.

CALDERA: A large, basin-shaped volcanic depression in the earth's surface, usually circular.

CAMS: Consolidated Aircraft Maintenance Squadron.

Cd: Chemical symbol for cadmium.

CE: Civil Engineering.

CERCLA: Comprehensive Environmental Response, Compensation and Liability Act.

CES: Civil Engineering Squadron.

CIRCA: About; used to indicate an approximate date.

CLINKER: A rough, jagged pyroclastic fragment, (such as "aa") resembling the clinker or slag of a furnace; usually smaller than 15 cm in diameter.

CLOSURE: The completion of a set of rigidly defined functions for a hazardous waste facility no longer in operation.

CMS: Component Maintenance Squadron.

CN: Chemical symbol for cyanide.

COD: Chemical Oxygen Demand, a measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water.

COE: Corps of Engineers.

COLLUVIUM: Sediments that have moved down slope primarily under the influence of gravity or as periodic, unchannelized flow. It frequently includes large boulders or other fragments which contrast this material to alluvium, material deposited by channelized flow which results in some degree of sorting according to particle size.

CONFINED AQUIFER: An aquifer bounded above and below by impermeable strata or by geologic units of distinctly lower permeability than that of the aquifer itself.

CONFINING UNIT: An aquitard or other poorly permeable layer which restricts the movement of ground water.

CONTAMINATION: The degradation of natural water quality to the extent that its usefulness is impaired; there is no implication of any specific limits since the degree of permissible contamination depends upon the intended end use or uses of the water.

Cr: Chemical symbol for chromium.

Cu: Chemical symbol for copper.

DBCP: Abbreviation for Dibromochloropropane.

DET: Detachment.

2,4-D: Abbreviation for 2,4-dichlorophenoxyacetic acid, a common weed killer and defoliant.

DIBROMOCHLOROPROPANE: A soil fumigant.

DIP: The angle at which a stratum is inclined from the horizontal.

DISPOSAL FACILITY: A facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at which waste will remain after closure.

DISPOSAL OF HAZARDOUS WASTE: The discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground water.

DOD: Department of Defense.

DOWNGRADIENT: In the direction of decreasing hydraulic static head; the direction in which ground water flows.

DPDO: Defense Property Disposal Office, previously included Redistribution and Marketing (R&M) and Salvage.

DUMP: An uncovered land disposal site where solid and/or liquid wastes are deposited with little or no regard for pollution control or aesthetics; dumps are susceptible to open burning and are exposed to the elements, disease vectors and scavengers.

EDB: Abbreviation for ethylene dibromide.

EFFLUENT: A liquid waste discharge from a manufacturing or treatment process, in its natural state, or partially or completely treated, that discharges into the environment.

EP: Extraction Procedure, the EPA's standard laboratory procedure for leachate generation.

EPA: U.S. Environmental Protection Agency.

EPHEMERAL: Short-lived or temporary.

EPHEMERAL AQUIFER: A water-bearing zone typically located near the surface which normally contains water seasonally.

EROSION: The wearing away of land surface by wind, water, or chemical processes.

ES: Engineering-Science, Inc.

ETHYLENE DIBROMIDE: Agent for removing lead from gasoline; used in past as grain and fruit fumigant; general solvent.

FAA: Federal Aviation Administration.

FACILITY: Any land and appurtenances thereon and thereto used for the treatment, storage and/or disposal of hazardous wastes.

FAULT: A fracture in rock along which the adjacent rock surfaces are differentially displaced.

Fe: Chemical symbol for iron.

FIRE CONTROL FACILITY: Military term used in reference to antiaircraft fire control operations.

FLOOD PLAIN: The lowland and relatively flat areas adjoining inland and coastal areas of the mainland and off-shore islands, including, at a minimum, areas subject to a one percent or greater chance of flooding in any given year.

FLOW PATH: The direction or movement of ground water as governed principally by the hydraulic gradient.

FMS: Field Maintenance Squadron.

FPTA: Fire Protection Training Area.

GC/MS: Gas chromatograph/mass spectrophotometer, a laboratory procedure for identifying unknown organic compounds.

GROUND WATER: Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure.

GROUND WATER RESERVOIR: The earth materials and the intervening open spaces that contain ground water.

HALOGEN: The class of chemical elements including fluorine, chlorine, bromine, and iodine.

HARDFILL: Disposal sites receiving construction debris, wood, miscellaneous spoil material.

HARM: Hazard Assessment Rating Methodology.

HANG: Hawaii Air National Guard.

HARNG: Hawaii Army National Guard.

*HAZARDOUS SUBSTANCE: Under CERCLA, the definition of hazardous substance includes:

1. All substances regulated under Paragraphs 311 and 307 of the Clean Water Act (except oil);

2. All substances regulated under Paragraph 3001 of the Solid Waste Disposal Act;

3. All substances regulated under Paragraph 112 of the Clean Air Act;

4. All substances which the Administrator of EPA has acted against under Paragraph 7 of the Toxic Substance Control Act;

5. Additional substances designated under Paragraph 102 of the Superfund bill.

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*For purposes of this Phase I IRP report hazardous substances and hazardous wastes are considered synonymous.

*HAZARDOUS WASTE: As defined in RCRA, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

HAZARDOUS WASTE GENERATION: The act or process of producing a hazardous waste.

HEAVY METALS: Metallic elements, including the transition series, which include many elements required for plant and animal nutrition in trace concentrations but which become toxic at higher concentrations.

Hg: Chemical symbol for mercury.

HQ: Headquarters.

HWMF: Hazardous Waste Management Facility.

HYDROCARBONS: Organic chemical compounds composed of hydrogen and carbon atoms chemically bonded. Hydrocarbons may be straight chain, cyclic, branched chain, aromatic, or polycyclic, depending upon arrangement of carbon atoms. Halogenated hydrocarbons are hydrocarbons in which one or more hydrogen atoms has been replaced by a halogen atom.

INCOMPATIBLE WASTE: A waste unsuitable for commingling with another waste or material because the commingling might result in generation of extreme heat or pressure, explosion or violent reaction, fire, formation of substances which are shock sensitive, friction sensitive, or otherwise have the potential for reacting violently, formation of toxic dusts, mists, fumes, and gases, volatilization of ignitable or toxic chemicals due to heat generation in such a manner that the likelihood of contamination of ground water or escape of the substance into the environment is increased, any other reaction which might result in not meeting the air, human health, and environmental standards (CFR 264.17 and 265.17).

INFILTRATION: The movement of water through the soil surface into the ground.

IRP: Installation Restoration Program.

IS: Island.

ISOPACH: Graphic presentation of geologic data, including lines of equal unit thickness that may be based on confirmed (drill hole) data or indirect geophysical measurement.

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*For purposes of this Phase I IRP report hazardous substances and hazardous wastes are considered synonymous.

JP-4: Jet Propulsion Fuel Number Four, military jet fuel.

LEACHATE: A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water.

LEACHING: The process by which soluble materials in the soil, such as nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

LENTICULAR: A bed or rock stratum or body that is lens-shaped.

LINER: A continous layer of natural or man-made materials beneath or on the sides of a surface impoundment, landfill, or landfill cell which restricts the downward or lateral escape of hazardous waste, hazardous waste constituents or leachate.

LITHOLOGY: The description of the physical character of a rock.

LOESS: An essentially unconsolidated unstratified calcareous silt; commonly homogeneous, permeable and buff to gray in color.

LOX: Liquid oxygen.

LYSIMETER: A vacuum operated sampling device used for extracting pore water samples at various depths within the unsaturated zone.

MAC: Military Airlift Command.

METALS: See "Heavy Metals".

MGD: Million gallons per day.

MOA: Military Operating Area.

MOGAS: Motor gasoline.

Mn: Chemical symbol for manganese.

MODIFIED MERCALLI INTENSITY: A number describing the effects of an earthquake on man, structures and the earth's surface. A Modified Mercalli Intensity of I is not felt. An intensity of VI is felt indoors and outdoors and for an intensity of VII it becomes difficult for a man to remain standing. Intensities of IX to XII involve increasing levels of destruction with destruction being nearly total at an intensity of XII.

MONITORING WELL: A well used to measure ground-water levels and to obtain samples.

MOTU: Island.

MSL: Mean Sea Level.

MWR: Morale, Welfare and Recreation.

NCO: Non-commissioned Officer.

NCOIC: Non-commissioned Officer In-Charge.

NET PRECIPITATION: The amount of annual precipitation minus annual evaporation.

NGVD: National Geodetic Vertical Datum of 1929.

Ni: Chemical symbol for nickel.

NOAA: National Oceanic and Atmospheric Administration.

NPDES: National Pollutant Discharge Elimination System.

OEHL: Occupational and Environmental Health Laboratory.

OIC: Officer-In-Charge.

OMS: Organizational Maintenance Squadron.

ORGANIC: Being, containing or relating to carbon compounds, especially in which hydrogen is attached to carbon.

OSI: Office of Special Investigations.

O&G: Symbols for oil and grease.

PACAF: Pacific Air Forces.

PAHOEHOE: A type of lava flow having a smooth, glassy, billowy or undulating surface.

Pb: Chemical symbol for lead.

PCB: Polychlorinated biphenyl; liquids used as a dielectric in electrical equipment.

PD-680: Stoddard solvent, dry cleaning solvent.

PERCHED WATER TABLE: A water table above a relatively impermeable zone underlain by unsaturated rocks of sufficient permeability to allow ground-water movement.

PERCOLATION: Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil.

PERMEABILITY: The capacity of a porous rock, soil or sediment for transmitting a fluid without damage to the structure of the medium.

PERSISTENCE: As applied to chemicals, those which are very stable and remain in the environment in their original form for an extended period of time.

PESTICIDE: An agent used to destroy pests. Pesticides include such specialty groups as herbicides, fungicides, insecticides, etc.

pH: Negative logarithm of hydrogen ion concentration with the range 1 to 7 as acidic and 7 to 14 as basic.

PL: Public Law.

PMRF: Pacific Missle Range Facility (Navy).

POL: Petroleum, Oils and Lubricants.

POLLUTANT: Any introduced gas, liquid or solid that makes a resource unfit for a specific purpose.

POLYCYCLIC COMPOUND: All compounds in which carbon atoms are arranged into two or more rings, usually aromatic in nature.

POTENTIALLY ACTIVE FAULT: A fault along which movement has occurred within the last 25-million years.

POTENTIOMETRIC SURFACE: The imaginery surface to which water in an artesian aquifer would rise in tightly screened wells penetrating it.

PPB: Parts per billion by weight.

PPM: Parts per million by weight.

PRECIPITATION: Rainfall and Snowfall.

PT: Point.

QAE: Quality Assurance Evaluator.

QUATERNARY MATERIALS: The second period of the Cenozoic geologic era, following the Tertiary, and including the last 2-3 million years.

RCRA: Resource Conservation and Recovery Act.

RECEPTORS: The potential impact group or resource for a waste contamination source.

RECHARGE AREA: A surface area in which surface water or precipitation percolates through the unsaturated zone and eventually reaches the zone of saturation. Recharge areas may be natural or manmade.

RECHARGE: The addition of water to the ground-water system by natural or artificial processes.

RECON: Reconnaissance.

RIPARIAN: Living or located on a riverbank.

RM: Resource Management.

SANITARY LANDFILL: A land disposal site using an engineered method of disposing solid wastes on land in a way that minimizes environmental hazards.

SAPROLITE: A residual soil retaining the physical appearance or former structure of the parent rock.

SATURATED ZONE: That part of the earth's crust in which all voids are filled with water.

SAX'S TOXICITY: A rating method for evaluating the toxicity of chemical materials as presented in a handbook by Sax.

SCS: U.S. Department of Agriculture Soil Conservation Service.

SEISMICITY: Pertaining to earthquakes or earth vibrations.

SLUDGE: The solid residue resulting from a manufacturing or wastewater treatment process which also produces a liquid stream. Also, the residue which accumulates in fuel tanks.

SOLID WASTE: Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations and from community activities, but does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 USC 880); or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923).

SP: Spill area.

SPILL: Any unplanned release or discharge of a hazardous waste onto or into the air, land, or water.

STORAGE OF HAZARDOUS WASTE: Containment, either on a temporary basis or for a longer period, in such a manner as not to constitute disposal of such hazardous waste.

STP: Sewage Treatment Plant.

STS: Satellite Tracking Station.

TAC: Tactical Air Command

TCE: Trichloroethylene, a solvent and suspected carcinogen.

2,4,5-T: Abbreviation for 2,4,5-trichlorophenoxyacetic acid, a common herbicide.

TDS: Total Dissolved Solids.

TOC: Total Organic Carbon.

TOXICITY: The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism.

TRANSMISSIVITY: The rate at which water is transmitted through a unit width of aquifer under a unit hydraulic gradient.

TREATMENT OF HAZARDOUS WASTE: Any method, technique, or process including neutralization designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize the waste or so as to render the waste nonhazardous.

1,2,3-TRICHLOROPROPANE: Paint and varnish remover, solvent, degreasing agent.

TSD: Treatment, storage or disposal.

UNCONFORMITY: A substantial break or gap in the geologic record, usually the result of a prolonged erosional period prior to the deposition of the succeeding layer in the stratigraphic column. It may be recognized by the fact that an overlying stratum does not correspond to the next or following age in geologic history.

UPGRADIENT: In the direction of increasing hydraulic static head; the direction opposite to the prevailing flow of groundwater.

USAF: United States Air Force.

USAFSS: United States Air Force Security Service.

USDA: United States Department of Agriculture.

USFWS: United States Fish and Wildlife Service.

USGS: United States Geological Survey.

USMC: United States Marine Corps.

USN: United States Navy.

VESICULAR: Refers to the texture of a rock, especially lava, which may have abundant cavities of variable shape and size formed by the entrapment of expanding gas during the solidification of the material.

WATER TABLE: Surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.

WSMC: Western Space and Missile Center.

WWTP: Wastewater Treatment Plant.

Zn: Chemical symbol for zinc.

APPENDIX J

REFERENCES

REFERENCES

1. Board of Water Supply, 1980. State of the Ground-Water Resources of Southern Oahu. BWS, City and County of Honolulu.

2. Board of Water Supply, 1982. Oahu Water Plan, Fourth Ed. Summary Report. BWS, City and County of Honolulu.

3. Burt, R.J., 1979. Availability of Ground Water for Irrigation on the Kekaha-Mana Coastal Plain, Island of Kauai, Hawaii Department of Land and Natural Resources Report R53.

4. Division of Water and Land Development, 1964. Kokee Water Project, Island of Kauai, Hawaii: A Report on the Feasibility of Water Development. Hawaii Department of Land and Natural Resources Report R22.

5. Engineering-Science, Inc., Sunn, Low, Tom and Hara, Inc. and Dillingham Environmental Co., 1972. Water Quality Program for Oahu with Special Emphasis on Waste Disposal: A Report for the City and County of Honolulu, State of Hawaii.

6. Garties, George, 1984. "Mililani cleanup will cost $2 million," in the Honolulu Advertiser, Saturday, May 12, page A-3.

7. Hawaii Division of Forestry and Wildlife, 1983. Endangered and Threatened Animals and Plants of Hawaii. Hawaii Department of Land and Natural Resources, Honolulu.

8. Hawaii Water Authority, 1959. Water Resources in Hawaii. Hawaii Water Authority, Honolulu.

9. Hobbs, William Herbert, 1945. Fortress Islands of the Pacific. J.W. Edwards, Inc., Ann Arbor, MI, pages 75-77.

10. Logan, Malcolm H. and Lum, Daniel, 1966. Engineering Geology Supplement for the Kokee Water Project, Island of Kauai, Hawaii. Hawaii Department of Land and Natural Resources Report R22A.

11. MacDonald, Gordon A., Davis, Dan A. and Cox, Doak C., 1960. Geology and Ground-Water Resources of the Island of Kauai, Hawaii. Hawaii Division of Hydrography, Bulletin 13.

12. Mink, John F., 1980. The Perched Aquifer at Kunia, Oahu. Interim consultant's report to Del Monte, Inc.

13. Mink, John F., 1981. DBCP and EDB in Soil and Water at Kunia, Oahu, Hawaii. Consultant's report to Del Monte, Inc.

14. Nakahara, R. H., 1978. Water Use in Hawaii, 1975. Hawaii Department of Land and Natural Resources Report R58.

15. Rosenau, J.C., Lubke, E.R. and Nakahara, R.H., 1971. Water Resources of North-Central Oahu, Hawaii. U.S. Geological Survey Water-Supply Paper 1899-D.

16. State of Hawaii, 1981. Title 11, Chapter 55: Water Pollution Control. Hawaii Department of Health, Honolulu.

17. State of Hawaii, 1982a. Title 13, Subtitle 5 (Forestry and Wildlife), Part 2, Chapter 124: Rules Regulating the Management and Protection of Indigenous Wildlife, Endangered and Threatened Wildlife and Plants and Introduced Wild Birds. Hawaii Department of Land and Natural Resources, Honolulu.

18. State of Hawaii, 1982b. Title 11, Chapter 54: Water Quality Standards. Hawaii Department of Health, Honolulu.

19. State Water Commission, 1979. Hawaii's Water Resources: Directions for the Future. A Report to the Governor. SWC, Honolulu.

20. Stearns, Harold T., 1946, revised 1967. Geology of the Hawaiian Islands. Hawaii Department of Land and Natural Resources Bulletin 8.

21. Stearns, Harold T., 1974. Geologic Description of Quarries on Oahu, Hawaii. Hawaii Department of Land and Natural Resources Circular C67.

22. Takasaki, Kiyoshi J., 1974. Hydrologic Conditions Related to Subsurface and Surface Disposal of Wastes in Hawaii. U.S. Geological Survey Open-File Report I-74.

23. Takasaki, Kiyoshi J., 1977. Elements Needed in Design of a Ground-Water Quality Monitoring Network in the Hawaiian Islands. U.S. Geological Survey Water-Supply Paper 2041.

24. Takasaki, Kiyoshi J., 1978. Summary Appraisals of the Nation's Ground-Water Resources - Hawaii Region. U.S. Geological Survey Professional Paper 813-M.

25. Takasaki, Kiyoshi J. and Mink, John F., 1982. Water Resources of Southern Oahu, Hawaii. U.S. Geological Survey Water Resources Investigations 82-628.

26. University of Hawaii, Department of Geography, 1983. Atlas of Hawaii, Second Edition. University of Hawaii Press, Honolulu.

27. U.S. Department of Agriculture, Soil Conservation Service, 1972a. Soil Survey Interpretations of Kauai. Hawaii Department of Land and Natural Resources Report R41.

28. U.S. Department of Agriculture, Soil Conservation Service, 1972b. Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii.

29. U.S. Department of the Interior, Fish and Wildlife Service, 1983. Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12).

30. Personal communication, Thomas E. Arizumi, Chief, Drinking Water Section, Hawaii Department of Health, 1984.

APPENDIX K

INDEX OF REFERENCES TO POTENTIAL
CONTAMINATION SITES AT 15TH ABW SATELLITE INSTALLATIONS

APPENDIX K
INDEX OF SITES
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